SINSW C/- Fulton Trotter Architects

Supplementary Geotechnical Investigation: Cronulla High School, Captain Cook Drive, Cronulla, NSW

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martens consulting engineers

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Head Office
Suite 201, 20 George St
Hornsby, NSW 2077, Australia
ACN 070 240 890 ABN 85 070 240 890
Phone: +61-2-9476-9999
Fax: +61-2-9476-8767
Email: mail@martens.com.au
Web: www.martens.com.au

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Author(s)	Reviewer(s)	Project Manager	Signature
Wasiul Bari	Kenneth Burgess	Jeffrey Fulton	

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All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Proposed Development and Investigation Scope

Table 1 summarises proposed development details and investigation scope.

Table 1: Summary of proposed development details and investigation scope.

Item	Details
Property address	Cronulla High School, Captain Cook Drive, Cronulla, NSW (the site).
Lot/DP	Lot 1 in DP815804 (Landpartners, 2020)
LGA	Sutherland Shire Council ('Council')
Proposed development	We understand from the proposal plans (FTA, 2022; FTA, 2021a and 2021b, refer Attachment B) that the development will include: o Construction of two new double storey buildings (i.e. Buildings L & M) in the southern and western portions of the site with finished floor level of approximately 5.45 mAHD. Limited excavation or filling (i.e. less than 1 m) will be required as part of construction of the proposed development (Cardno, 2022, refer Attachment C). o Internal alteration and additions to Building D. o Relocation of Building I to the northeast of Building L. o Construction of a new carpark in the north western portion of the site. o Construction of an onsite stormwater detention (OSD) tank beneath the new carpark in the west of Building L with bulk excavation level of 3.6 mAHD (Cardno, 2022). Bulk excavation up to approximately 2.0 m below ground level (mbgl) will likely be required for OSD basin construction.
Assessment purpose	The purpose of this supplementary geotechnical assessment to support a Development Application (DA) as well as assist structural design of already approved development associated with Cronulla high school redevelopment.
Investigation scope of work	Initial geotechnical related field investigations conducted on 22 and 23 May 2021 included: o Review of DBYD survey plans and buried service locating on site. o General site walkover to review local geology, soil exposures, surface hydrology, topography and drainage at the site. o Drilling of ten boreholes (BH101 to BH110) up to 10.0 mbgl via solid flight auger. o Collection of soil samples for laboratory testing and future reference. o Ten dynamic cone penetrometer (DCP) tests (DCP101 to DCP110) up to 7.1 mbgl. o Measurement of groundwater table in existing monitoring wells (MW01 to MW04) located across the site. Supplementary geotechnical field investigation conducted between 6 and 7 July 2022 included: o Four Cone Penetration Tests (CPT-01 to CPT-04) in the vicinity of Building M up to 9.91 m below ground level (mbgl). o Three Cone Penetration Tests (CPT-05 to CPT-07) in the vicinity of Building L

Item	Details
	up to 14.86 mbgl. Investigation locations are shown on Map 01, Attachment A. Refer Attachment E for borehole logs and explanatory notes in Attachment K. CPT logs are presented in Attachment F. For DCP test results, refer Attachment G.
Laboratory testing	Laboratory testing carried out by National Association of Testing Authorities (NATA) accredited laboratories included: o CBR (California Bearing Ratio) testing on two bulk soil samples and particle size distribution (PSD) testing on six soil samples by Resource Laboratories. o sPOCAS analysis on fourteen soil samples and Aggressivity testing (ph, EC, SO_4, Cl, resistivity) on twenty soil samples by Envirolab Services. Laboratory test certificates are provided in Attachment I.

2 General Site Details and Subsurface Conditions

2.1 General Site Details

General site details are summarised in Table 2.

Table 2: Summary of general site details based on desktop review and site walkover.

Item	Comment
Topography	Level to undulating disturbed terrain, immediately to the southeast of Woolooware Warden Lagoon, approximately 570 m northwest of Bate Bay.
Typical Slopes, Aspect, Elevation	Site elevation ranges between approximately 2.0 mAHD (south western portion) and 6.0 mAHD (south eastern portion) (Landpartners, 2020). The site has a north / north westerly aspect with an overall grade of less than 5% except along the north and north western site boundary where the slopes are approximately between 15 – 25 %.
Expected geology	The site is mapped as being underlain by Quaternary deposits, consisting of medium to fine marine quartz sand with podsols (Wollongong - Port Hacking 1:100 000 Geological Sheet 9029-9129, 1st edition).
Expected soil landscape	The NSW Office of Environment and Heritage's (OEH) information system (eSPADE) indicates the site to be located in the Disturbed Terrain soil landscape consisting of landfill comprising soil, rock, building and waste materials. Dependent on the nature of fill material this soil landscape often associated with mass movement hazard, unconsolidated low wet strength materials, impermeable soil, poor drainage and toxic materials.
Existing site description	At the time of the geotechnical investigation, the site consisted of: o Cronulla High School, including multiple school buildings, teaching and sport facilities, on-grade parking, vegetation, and fields. o Asphalt paved carpark at western portion and concrete paved surface within the school vicinity area.
Drainage	Drainage of the site is via overland flow and internal school stormwater network towards the Council stormwater system in Captain Cook Drive.
Neighbouring environment	The site is bounded by low to medium density residential properties to the west and south, and public recreational facilities to the north and east. The investigation area is surrounded by: o Bate Bay Road and Elouera Road to the west. o Captain Cook Drive to the north. o Commercial and residential buildings to the west. o Sports oval to the north east corner of the site.

2.2 Subsurface Conditions

Based on our investigations (borehole, CPT and DCP testing) undertaken at the site, the following generalised subsurface units underlie the site below ground surface level:

Unit A: Poorly to moderately compacted fill comprising silty sand / gravelly sand encountered in the north western portion

of the site, up to between approximately 0.4 mbgl (BH102) and 1.3 mbgl (BH105). Fill depth increases to at least 3.7 mbgl (BH110) towards the southwestern end of the site. Fill is inferred to have been placed under uncontrolled conditions possibly for previous landscaping and / or levelling purposes.

Unit B: Topsoil comprising loose silty sand was encountered in the vegetated area along the northwestern portion of the site (BH108), up to approximately depth of 0.3 mbgl.

Unit C: Aeolian / marine deposits comprising:

Unit C1: Generally loose sand / silty sand with interbedded loose to medium dense and medium dense layers encountered up to between approximately 2.4 m (BH103) and 4.8 mbgl (CPT02, CPT03, CPT05 and CPT07) across the site.

Unit C2: Medium dense sand encountered up to approximately 6.2 mbgl (CPT05).

Unit C3: Dense grading to very dense sand at some locations, with interbedded loose layers encountered up to maximum CPT investigation termination depth of 14.86 mbgl.

A summary of the subsurface units encountered at CPT locations and in all boreholes is presented in Tables D1 and D2, Attachment D.

3 Hydrogeological Assessment

3.1 Mapping

A search of the Bureau of Meteorology groundwater bore database indicates that no groundwater bores with available groundwater data are located within 200 m of the site.

3.2 Existing Well Information

Four existing groundwater wells (MW01 to MW04) were identified during initial site investigations adjacent to Building M in the south eastern portion of the site. Well depths and standing groundwater level measurements are summarised in Table 3. MW04 was not accessible during the time of investigations. Well construction details (i.e. screen / casing depths) could not be determined and no information has been provided to MA with regards to when or how the groundwater wells were installed.

Table 3: Existing Groundwater Well details.

Well ID	Total Depth of Well (mbgl)	Depth to Water [1] (mbgl)	Approximate Depth to Water (mAHD)
MW01	6.60	4.60	0.69
MW02	6.20	4.30	1.10
MW03	6.00	4.21	1.14
MW04	N/A [2]	N/A [2]	N/A [2]

Notes:

1. Recorded 23 May 2021.
2. N/A – access to groundwater well was not available during inspection.
3. Based in an assumed surface levels from site survey (Landpartners, 2020).

We note that prior to the supplementary investigation, the driveway to the east of Building M had been recently resurfaced and the wells documented in Table 1 above had been lost.

3.3 Groundwater Observations During Intrusive Testing

Groundwater was encountered during all CPT probing and drilling of all boreholes except for BH110. A summary of groundwater inflow level observed during CPT probing and drilling of boreholes is provided in Table 4.

Table 4: Summary of groundwater levels observed during borehole drilling.

Location	Geology	Surface Level (mAHD) [1]	Depth of Groundwater (mbgl)	Groundwater Level (mAHD)	Date
CPT01	Quaternary	5.40	3.50	1.90	06.07.2022
CPT02	Quaternary	5.20	3.40	1.80	06.07.2022
CPT03	Quaternary	5.30	3.40	1.90	06.07.2022
CPT04	Quaternary	5.20	3.40	1.80	06.07.2022
CPT05	Quaternary	5.50	3.70	1.80	07.07.2022
CPT06	Quaternary	5.30	3.40	1.90	07.07.2022
CPT07	Quaternary	5.20	3.40	1.80	07.07.2022
BH101	Quaternary	5.32	5.00	0.32	22.05.2021
BH102	Quaternary	5.40	5.50	-0.10	22.05.2021
BH103	Quaternary	5.12	4.50	0.61	22.05.2021
BH104	Quaternary	5.43	4.50	0.93	22.05.2021
BH105	Quaternary	5.20	4.20	1.00	23.05.2021
BH106	Quaternary	5.29	2.10	3.19	23.05.2021
BH107	Quaternary	5.29	3.50	1.79	23.05.2021
BH108	Quaternary	2.41	1.50	0.91	23.05.2021
BH109	Quaternary	2.83	2.60	0.23	23.05.2021

Notes:

1. Based on Landpartners, 2020.

3.4 Groundwater Discussions

Based on our observation of groundwater inflow we conclude the following:

- Groundwater was encountered between approximately 3.2 mAHD and -0.10 mAHD. Based on our observation of groundwater levels, a design groundwater level of 3.2 mAHD has been adopted for the purpose of this report.

- Groundwater is expected to flow variably in the northeast, north and northwest directions towards the Woolooware Bay, however a triangulated groundwater well network and monitoring would be required to confirm this.

- Excavations up to 3.6 mAHD for the OSD tank is unlikely to intercept the permanent groundwater table at 3.2 mAHD. However, groundwater level may vary in the long term depending on seasonal / climate conditions and variations in lagoon water levels.

4 Acid Sulfate Soils Assessment

4.1 Preliminary Assessment

4.1.1 ASS Risk Map

The Sutherland Shire LEP (2015) ASS map indicates that the site is mapped as Class 4 ASS risk. Site location relating to ASS risk is presented in Figure 1. The Sutherland Shire LEP (2015) states that works on Class 4 land being undertaken at a depth greater than 2 mbgl, or which are likely to lower the water table by more than 2 mbgl, may require a management plan or preliminary assessment prior to development consent.

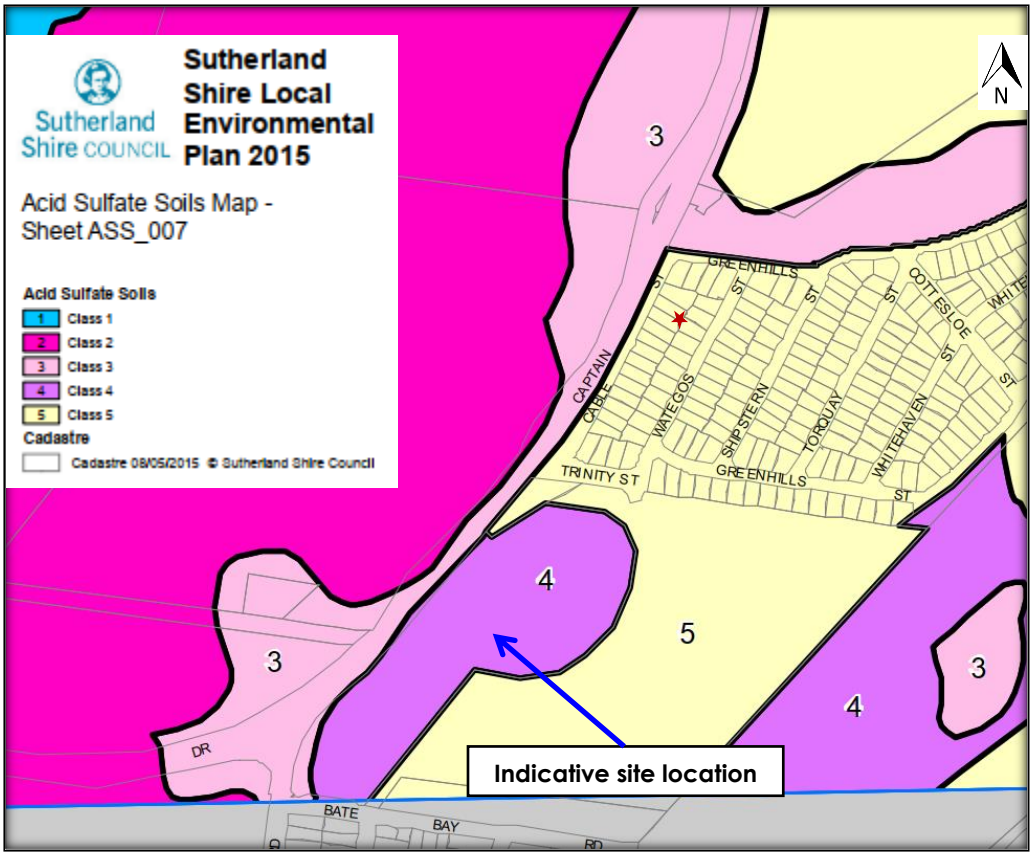

Figure 1: Sutherland Shire LEP, 2015, showing site location relative to risk classes.

4.1.2 Geomorphic Setting

Geomorphic parameters for the site which may indicate ASS presence are listed in Table 5 as derived from ASSMAC (1998).

Table 5: Site geomorphic features.

Geomorphic Feature	Present on site?
Holocene sediments	Possible
Soil horizons less than 5 m AHD	Yes
Marine / estuarine sediments or tidal lakes	Yes
Coastal wetland; backwater swamps; waterlogged or scalded areas; inter-dune swales or coastal sand dunes (i.e. deep excavation is required)	No
Dominant vegetation of mangroves, reeds, rushes and other swamp or marine tolerant species.	Not currently
Geologies containing sulfide bearing material / coal deposits or former marine shales/sediments	No
Deep older (Holocene or Pleistocene) estuarine sediments	Possible

The geomorphic setting of the site indicates that there is a likelihood of ASS presence, as four of the listed geomorphic features are present or possibly present.

Subsequently, preliminary laboratory testing of soil samples was undertaken to assess ASS risk for the site.

4.2 sPOCAS Assessment

4.2.1 Results

A summary of ASS sPOCAS test results is provided in Attachment H, with the laboratory certificates provided in Attachment I.

Based on the pH_{KCL} and post peroxide oxidation pH_{OX} criteria derived from the ASSMAC (1998) guidelines:

- Soils with a pH_{KCL} of $\leq$ 4.0 are classified as actual ASS (AASS).
- Soils with pH_{KCL} - pH_{ox} > 1 are classified as potential ASS (PASS).
- Soils with pH_{ox} < 3.5 are classified as PASS.

On the basis of these criteria, out of the fourteen tested samples, none are classified as AASS and five are preliminarily classified as PASS (refer Attachment H).

4.2.2 Action Criteria

According to Table 4.4 of ASSMAC (1998), a detailed management plan is required if the soil exhibits one of the following criteria (for <1,000 tonnes disturbed soil):

- Oxidisable sulphur (SPOS) is ≥ 0.03%; or
- TPA or TSA is ≥18 mol H+/tonne.

On the basis of these action criteria none of the samples exceed the criteria based on either S_{pos}, TPA and / or TSA.

4.3 Discussion and Recommendations

Laboratory test results indicate that none of the tested soil samples exceed the action criteria for the acid trail. Therefore, excavation in the proposed development areas will not require preparation of a management plan to address risk associated with ASS and potential acid generation.

5 Geotechnical Assessment

5.1 Laboratory Test Results

5.1.1 California Bearing Ratio (CBR) Testing

Laboratory CBR tests with standard compaction, were carried out on 2 bulk soil samples. CBR test results are summarised in Table 6.

Table 6: CBR test results.

Borehole Number	Depth (mbgl)	Soil Type	CBR Value (%)
BH109	0.2 – 0.7	SAND, with Silt (FILL)	19
BH110	1.0 – 1.5	SAND, with Silt (FILL)	17

5.1.2 Particle Size Distribution (PSD) Testing

Laboratory PSD tests were carried out on 6 soil samples to determine soil grading. The test results are provided in Attachment I, and summarised in Table 7. Note that detailed hydrometer analysis was not performed in samples where the total content of fine soils (silt and clay) was less than 10%.

Table 7: PSD test results.

BH ID	Depth (mbgl)	Gravel content (%)	Sand content (%)	Silt / Clay content (%)
BH101	1.3 – 1.4	2	96	2
BH105	1.0 – 1.1	2	93	5
	2.5 – 2.6	0	100	0
BH108	1.0 – 1.1	0	98	2
BH110	3.0 – 3.1	5	90	5
	1.5 – 1.6	8	88	4

5.1.3 Soil Aggressivity Testing

Laboratory soil aggressivity testing was carried out on twenty soil samples to evaluate exposure classification for concrete and steel. Test results for exposure classification are summarised in Table 8. A laboratory test certificate is presented in Attachment I.

Table 8: Exposure classification test results.

Sample ID[1]	EC_e (dS/m) [2, 6]	pH	Chloride (Cl) (mg/kg)	Sulphate (SO_4) (mg/kg)	Resistivity (Ohm m)	Exposure Classification		
						AS 2159 [3]	AS 2159 [4]	AS 3600 [5]
8205/BH101/0.5-0.6	1.7	9.6	<10	45	98	Non-aggressive	Non-aggressive	A1
8205/BH101/1.0-1.1	2.55	8.6	23	59	68	Non-aggressive	Non-aggressive	A1
8205/BH101/1.5-1.6	3.74	9.4	28	130	45	Non-aggressive	Non-aggressive	A1
8205/BH101/2.5-2.6	0.255	8.0	<10	<10	650	Non-aggressive	Non-aggressive	A1
8205/BH101/4.0-4.1	0.544	8.0	10	25	310	Non-aggressive	Non-aggressive	A1
8205/BH102/0.5-0.6	0.119	6.1	<10	<10	1400	Non-aggressive	Non-aggressive	A1
8205/BH102/1.5-1.6	0.288	6.6	<10	10	700	Non-aggressive	Non-aggressive	A1
8205/BH102/2.3-2.4	0.561	6.3	<10	21	300	Non-aggressive	Non-aggressive	A1
8205/BH102/4.0-4.1	0.238	6.7	<10	10	690	Non-aggressive	Non-aggressive	A1
8205/BH102/5.5-5.6	0.17	7.4	10	10	970	Mild	Non-aggressive	A2
8205/BH103/0.1-0.2	0.459	6.7	<10	<10	370	Non-aggressive	Non-aggressive	A1
8205/BH103/1.0-1.1	0.561	7.0	<10	<10	310	Non-aggressive	Non-aggressive	A1
8205/BH103/2.0-2.1	0.527	6.7	10	<10	330	Non-aggressive	Non-aggressive	A1
8205/BH103/4.0-4.1	0.272	6.8	<10	<10	630	Non-aggressive	Non-aggressive	A1
8205/BH103/5.5-5.6	0.187	7.6	<10	<10	940	Mild	Non-aggressive	A2
8205/BH106/0.5-0.6	1.462	9.9	20	42	120	Non-aggressive	Non-aggressive	A1
8205/BH106/1.0-1.1	0.51	8.2	<10	<10	330	Non-aggressive	Non-aggressive	A1
8205/BH106/2.0-2.1	0.629	8.4	<10	10	270	Non-aggressive	Non-aggressive	A1
8205/BH106/4.0-4.1	0.136	7.6	<10	<10	1200	Mild	Non-aggressive	A2
8205/BH106/5.5-5.6	0.187	7.8	<10	<10	930	Mild	Non-aggressive	A2

Notes:

1. Project#/Borehole#/Depth (mbgl).
2. Based on EC to EC_e multiplication factors from Table 6.1 in *Site Investigations for Urban Salinity* (2002) guidelines. A multiplication factor of 17 was adopted for sand.
3. Exposure classification for concrete piles in soil based on Table 6.4.2(C) of AS 2159 (2009).
4. Exposure classification for steel piles in soil based on Table 6.5.2(C) of AS 2159 (2009).
5. Exposure classification for buried reinforced concrete based on Tables 4.8.1 and 4.8.2 of AS 3600 (2018).
6. Based on Table 6.2 of DLWC (2002) where EC_e <2 dS/m = non-saline, EC_e of 2-4 dS/m = slightly saline, EC_e of 4-8 dS/m = moderately saline, EC_e of 8-16 dS/m = very saline and EC_e of >16 S/m = highly saline.

In accordance with AS3600 (2018, an exposure classification of 'A1' and 'A2' should be adopted for preliminary design of concrete footings founding above or below groundwater table, respectively. In accordance with AS 2159 (2009), an exposure classification of 'Mild' should be adopted for preliminary design of concrete piles. A soil aggressivity of 'non-aggressive' should be adopted for preliminary design of steel piles in accordance with AS 2159 (2009).

Sub-surface materials at the site can generally be categorised as non-saline. No specific saline soil management strategies are likely to be required. However, near surface marine sand in BH101 can be categorised as slightly-saline, therefore, further testing may need to be undertaken depending on the final development levels in this area, to delineate extent of potentially saline soils.

5.2 Material Properties

Material properties inferred from observations during borehole drilling, such as auger penetration resistance, CPT / DCP test results, and engineering judgement are summarised in Table 9.

Table 9: Preliminary estimates of soil strength properties.

Layer	$\gamma_{in\text{-}situ}$ [1] (kN/m³)	Ø' [2] (deg)	E' [3] (MPa)	K_0 [4]	K_a [4]	K_p [4]
FILL: Silty SAND (poorly compacted)	16	27	3	0.55	0.38	2.66
MARINE: SAND (loose)	16 (moist) 18 (wet)	28	6	0.53	0.36	2.77
MARINE: SAND (medium dense)	18 (moist) 19 (wet)	32	15 (moist) 8 (wet)	0.47	0.31	3.26
MARINE: SAND (dense to very dense)	20 (wet)	36	15 (wet)	0.41	0.26	3.85

Notes:

1. Material average in-situ unit weight, based on visual assessment.
2. Average effective internal friction angle estimate assuming drained conditions.
3. Average effective elastic modulus estimate.
4. k_0 = Coefficient of earth pressure at rest; k_a = Coefficient of active earth pressure; k_p = Coefficient of passive earth pressure.

5.3 Risk of Slope Instability

No evidence of recent or former land instability was observed within the site and surrounding land during the site walkover survey. The risk of potential slope instability, such as landslide or soil creep, is considered to be very low subject to the recommendations in this report and the adoption of relevant engineering standards and guidelines. A detailed slope risk assessment in accordance with Australian Geomechanics Society's Landslide Risk Management Guidelines (2007) was not undertaken as assessed to be not required.

5.4 Geotechnical Constraints

We consider the proposed development will likely be constrained by the following key geotechnical constraints:

- Presence of uncontrolled fill and loose marine deposits, considered unsuitable as foundation material for shallow footings due to low bearing capacity and possible excessive total and differential settlement under working load.
- Presence of shallow groundwater likely affects bearing capacity and may result in groundwater seepage and unstable ground during pile excavation.

6 Geotechnical Recommendations

Geotechnical recommendations for site development are provided below. Further general geotechnical recommendations are provided in Attachment J.

6.1 Proposed Footing Systems

Based on ground conditions encountered during the investigations, variable loose and medium dense marine sand deposits are present up to a depth of approximately 5.0 mbgl. Below this depth, ground conditions generally comprise medium dense, grading to dense with occasional thin loose layers up to approximately 0.75 m thick. Bedrock was not encountered during drilling.

6.1.1 Deep Foundations

Suitable foundations for new structures (e.g. Buildings L & M) are likely to comprise deepened footings, such as non-displacement pile systems (e.g. bored cast in-situ concrete piles or continuous flight auger (CFA) concrete piles) embedded at least 1.0 m or 1.5 x pile diameters (whichever is greater) into at least dense sand.

For bored cast in-situ concrete piles or CFA concrete piles, an allowable bearing capacity of 500 kPa may be adopted for piles founding in at least dense marine sand at a minimum depth of 6.5 mbgl. An allowable skin friction of 3 kPa may be adopted for the medium dense and dense sand. A lower bearing capacity of approximately 200 kPa may be adopted for shallower piles embedded in medium dense sands. We recommend ignoring skin friction in the top 1 m of pile as well as in the fill and loose marine sands.

For bored cast in-situ concrete piles, temporary steel casing should be provided to prevent collapsing marine sand into pile excavation. A tremmie pipe and casing would need to be used for concrete placement in bored cast in-situ piles installed in sandy soils and / or below the groundwater level. Delays between excavation completion and concrete placement should be limited to prevent weakening of foundation material. Bored pile excavation must consider possible material disturbance as a result of auger or cleaning bucket removal (suction impacts) and water pressures. Displacement piles (e.g. screw piles) may also be considered for lightly loaded structures. Design length of screw pile will depend on the type of proprietary system adopted and the end bearing achieved for the applied screw pile torque. Driven piles are not considered appropriate given the risk to

onsite and neighbouring structures from vibration induced settlement of underlying soils

All foundations are to be founded on consistent materials to minimise differential movements. All foundations should be inspected by a geotechnical engineer to confirm encountered conditions satisfy design assumptions.

6.1.2 Stiffened Raft Slab

Consideration may also be given to a reinforced concrete raft slab. A stiffened raft slab would distribute the applied load of the building over the soils underlying the slab. However structural loads can result in excessive settlements in loose sands from both immediate settlement and long term creep. The estimated preliminary bearing capacities for a raft slab founded on the natural sand strata underlying the site is estimated to be in the order of 40 kPa, depending on tolerable settlement criteria.

Bearing capacity and settlement characteristics can vary depending on actual raft foundation shape and dimensions. Foundation analysis should therefore be carried out at detailed design stage to determine bearing capacity and the magnitude and distribution of settlement to assess the effectiveness of the raft. Where settlements are found to be excessive, consideration may be given to adoption of settlement reducing piles which act in conjunction with the raft to create a potentially economical foundation solution for the support of the building loads.

6.2 Excavations

The proposed development does not involve any significant bulk excavations except for the OSD tank.

Excavations must be temporarily and permanently battered back / supported / retained to maintain excavation stability and limit potential adverse impacts on surrounding structures or neighbouring properties. Unsupported excavations deeper than 1.0 m should be assessed by a geotechnical engineer for instability risk.

Where there is sufficient setback to remain outside the zone of influence of adjacent structures / neighbouring properties, excavations in soils (above groundwater level) may be temporarily battered back at a gradient of 1V:2H. It is assumed that temporary excavation batters would remain unsupported for no more than two months. Recommended batters are subject to inspection and approval by an experienced geotechnical engineer on site and should be followed by

construction of permanent retaining structures. Maximum batter grades of 1V:3H should be adopted for longer term unsupported slopes.

Where excavations (e.g. OSD tank and south eastern edge of the carpark) are within the zone of influence of adjacent building, or where excavating below groundwater level, temporary structural support will be required to minimise impact of excavation on these structures. The type of support will depend on depth of excavation, soil strength and potential for groundwater seepage into the excavation.

Excavations up to 3.6 mAHD for the OSD tank is unlikely to intercept the design permanent groundwater level at 3.2 mAHD. However, considering limited clearance between the base of the OSD tank and design permanent groundwater level, we recommend minimising any over excavation for the OSD tank.

6.3 Earthworks

All earthworks should be carried out in accordance with AS3798 (2007), and should be inspected and approved by a qualified geotechnical engineer. Site-won excavated marine sand may be re-used as structural fill, subject to removal of any unsuitable inclusions (i.e. roots, organics, unsuitable building rubble and other deleterious materials).

Where uncontrolled fill or loose sand is exposed at the subgrade level of pavements, floor slabs or services, the material should be removed and replaced with engineered fill, or engineering design should account for issues relating to differential settlement and low bearing capacities.

6.4 Preliminary Pavement Assessment for Carpark

6.4.1 Overview

Preliminary flexible pavement thicknesses design for the proposed car park should be undertaken in accordance with Sutherland Shire Council's pavement design guidelines and Austroads - Guide to Pavement Technology Part 2: Pavement Structural Design (Austroads, 2017).

6.4.2 Design CBR

Test results returned CBR values of 17 % and 19 % for the fill materials. Considering the material type and condition, similar CBR value is expected for the marine sand subgrade. Given the limited laboratory testing, a subgrade CBR of 10 % may be adopted for pavement design.

6.5 Preliminary Site Classification

The site is classified as a class 'P' site in accordance with AS 2870 (2011) due to presence of uncontrolled fill and loose marine sand up to 4.8 mbgl (CPT03 and CPT07).

6.6 Drainage

Appropriate surface drainage should be provided to divert overland flows and limit ponding near footings and foundations.

All site discharges should be passed through a filter material prior to release. Collected flows should be directed (where possible) to a suitable stormwater system so as to prevent water accumulating in areas surrounding footings and pavements.

7 Proposed Additional Works

7.1 Works Prior to Detailed Design

We recommend that review of the final design is carried out by a senior geotechnical engineer to confirm adequate consideration of the geotechnical risks and adoption of the recommendations provided in this report.

7.2 Construction Monitoring and Inspection

We recommend the following as summarised in Table 10 is inspected and monitored during construction of the project.

Table 10: Recommended inspection / monitoring requirements during site works.

Scope of Works	Frequency/Duration	Who to Complete
Quality assurance (QA) of earthworks in accordance with AS3798 (2007).	As required [2] during earthworks	Builder / MA [1]
Proof rolling of exposed subgrade materials by a geotechnical engineer to verify suitability as subgrade for fill or pavement material placement	As required [2] / prior to fill placement	MA [1]
Inspect exposed material at foundation level to verify suitability as foundation / lateral support.	Prior to reinforcement set-up and concrete placement	MA [1]
Monitor sediment and erosion control structures to assess adequacy and for removal of built-up spoil.	After rainfall events	Builder
Pile inspection to confirm required allowable bearing capacity if in rock.	As required [2] during construction	MA [1]

Notes:

1. MA = Martens and Associates engineer.
2. MA inspection frequency to be determined based on initial inspection findings in line with construction program.

8 References

Cardno (2022) Cut and Fill Plan, Drawing nos. 80821341-CI-0107 and 80821341-CI-0108, Revision 1, dated 5 July 2022 (Cardno, 2022).

Fulton Trotter Architects (2022) *Architectural Drawings*, Drawing no. SD-1003, Revision no. 07, Project no. 7068CR04, dated 24 June 2022 (FTA, 2022).

Fulton Trotter Architects (2021) *Architectural Drawings*, Drawing nos. CD-M-201, Revision no. K; CD-M-202, Revision no. I; CD-M-203, Revision no. J; CD-M-301 and CD-M-311, Revision no. C; Project no. 7068CR01, dated 12 July 2021 (FTA, 2021a).

Fulton Trotter Architects (2021) *Architectural Drawings*, Drawing nos. CD-D-202, Revision no. D; CD-L-201, Revision no. K; CD-L-202, Revision no. H; CD-L-203, Revision no. E; CD-L-301 and CD-L-311, Revision no. A; Project no. 7068CR01, dated 8 June 2021 (FTA, 2021b).

Landpartners (2020) *Detailed Survey of Lot 1 DP 815804, Sheet Nos. 1 to 9, Plan* Ref. SY075045.000.1.1, dated October 2020 (Landpartners, 2020).

NSW Department of Environment & Heritage (2020), eSPADE, NSW soil and land information, www.environment.nsw.gov.au, accessed 05.08.2022.

Standards Australia Limited (1997) AS 1289.6.3.2-1997, Determination of the penetration resistance of a soil – 9kg dynamic cone penetrometer test, SAI Global Limited.

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Standards Australia Limited (2011) AS 2870-2011, Residential slabs and footings, SAI Global Limited.

Standards Australia Limited (2018) AS 3600-2018, Concrete Structures, SAI Global Limited.

Standards Australia Limited (2007) AS 3798-2007, Guidelines on earthworks for commercial and residential developments, SAI Global Limited.

Stroud W.J., Sherwin L., Roy H.N. and Baker C.J., 1985, Wollongong - Port Hacking 1:100 000 Geological Sheet 9029-9129, 1st edition. Geological Survey of New South Wales, Sydney.

Sutherland Shire Local Environmental Plan (2015) *Acid Sulfate Soils Map - Sheet ASS_007* (Sutherland Shire LEP, 2015).

9 Attachment A – Geotechnical Investigation Plan

0 9 18 27 36 45 m

1:750 @ A3

Viewport A

Aerial: Nearmap (May 2021)

Map Title / Figure:

Borehole & CPT Locations

Map 01	Map
Cronulla High School, Captain Cook Drive, Cronulla, NSW	Site
Cronulla High School Redevelopment	Project
Supplementary Geotechnical Assessment	Sub-Project
NSW Department of Education	Client
04/08/2022	Date

martens
Environment | Water | Geotechnics | Civil | Projects

Project No: P2108205 Map Set: MS03-R01 EPSG: 28356

10 Attachment B – Architectural Plans (FTA, 2022; FTA, 2021a and 2021b)

1 PLAN
PROPOSED SITE PLAN
SCALE: 1:500

01	CONSULTANT COORDINATION - PLANNER REVIEW	29/04/22	LW / NE
02	CONSULTANT COORDINATION	05/05/22	NE
03	CONSULTANT COORDINATION	10/05/22	NE
04	CONSULTANT COORDINATION ISSUE	19/05/22	LW / NE / JP
05	SCHEMATIC DESIGN ISSUE - DRAFT	02/06/22	LW / JP / SZ / NE
06	Consultant Co-ordination	20/06/22	LW
07	Consultant Co-ordination	24.06.22	LW
REV.	DESCRIPTION	DATE	INIT.

PROPOSED SITE PLAN LEGEND

- EXISTING BUILDINGS
- PERMANENT DEMOUNTABLE
- EXISTING TREE RETAINED
- ROOF OVER
- CONTOUR
- FENCE
- PROPOSED BUILDINGS
- PROPOSED COLA
- REFURBISHED AREAS
- PROPOSED TREES
- PROPOSED HYDRANT (FH)

fulton trotter ARCHITECTS
SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022
t. (02) 8383 5151
e. sydney@fultontrotter.com.au
BRISBANE
SYDNEY
DIRECTORS
Greg Isaac raia NSW 6855 QLD 2920
Justine Ebzery raia QLD 3313
John Ward raia VIC 18804 NSW 8371 QLD 3847
Katerina Dracopoulos raia QLD 4529
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Paul Sekava raia NSW 7180 QLD 3108
Paul Trotter fraia NSW 7177 QLD 2646
Ryan Loveday raia QLD 4500
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PHASE: **SCHEMATIC DESIGN**
CLIENT: NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)
PROJECT: CRONULLA HIGH SCHOOL
ADDRESS: Captain Cook Dr Cronulla, NSW

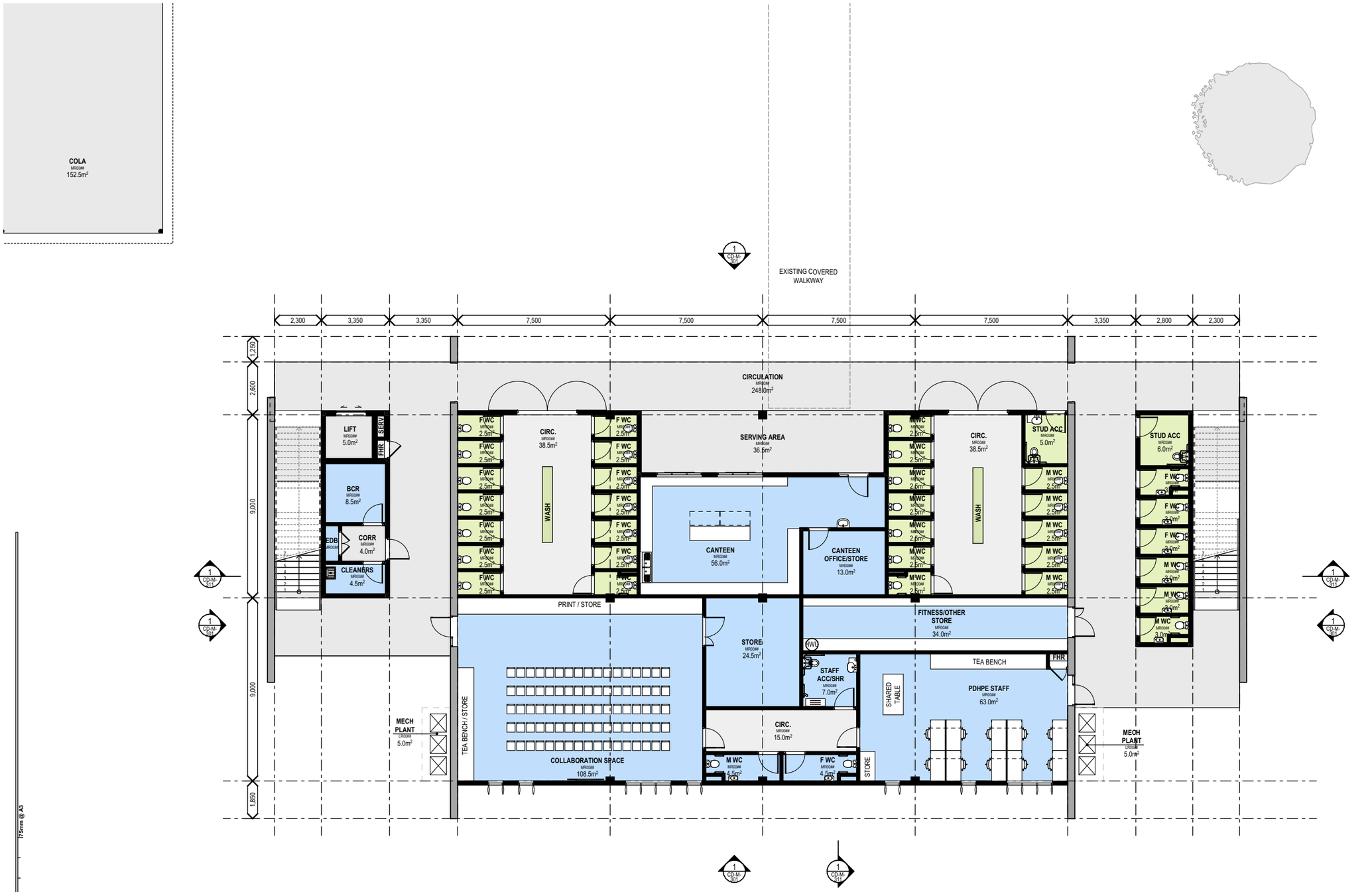
DRAWING: **PROPOSED SITE PLAN**

Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

PROJECT NUMBER: 7068CR04
DIRECTOR: JW
CHECKED:
DRAWING NUMBER: SD-1003
REVISION: 07

50 100 150mm @ A1

plot date: Friday, 24 June 2022 file location: BIMcloud: SYDBIM23 - BIMcloud Basic for ARCHICAD 23/7068CR01 - Cronulla HS - CONCEPT DESIGN



A	EFSG REVIEW	10/02/21	LW
B	USER GROUP WORKSHOP	15/02/21	LW
C	Preliminary Issue	18/03/21	LW
D	Preliminary Issue	23/03/21	LW
E	Preliminary Issue	08/04/21	LW
F	User Workshop	14/04/21	LW
G	Preliminary Issue	16/04/21	LW
H	Coordination Issue	05/05/21	JH
I	Coordination Issue	08/06/21	LW
J	Co-ordination Issue	30/06/21	LW
K	Co-ordination Issue	12/07/21	LW
REV.	DESCRIPTION	DATE	INIT.

0 0.5 1 2 3 Scale 1:100 @ A3 5m

25 50 75mm @ A3

plot date: Monday, 12 July 2021 file location: BIMcloud: SYDBIM23 - BIMcloud Basic for ARCHICAD 23/7068CR01 - Cronulla HS - CONCEPT DESIGN

fulton trotter ARCHITECTS

SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022

t. (02) 8383 5151
e. sydney@fultontrotter.com.au

BRISBANE
SYDNEY

DIRECTORS

Greg Isaac raia		NSW 6855	QLD 2920
Justine Ebzery raia			QLD 3313
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Paul Trotter fraia		NSW 7177	QLD 2646
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PHASE **CONCEPT DESIGN**

CLIENT NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)

PROJECT CRONULLA HIGH SCHOOL

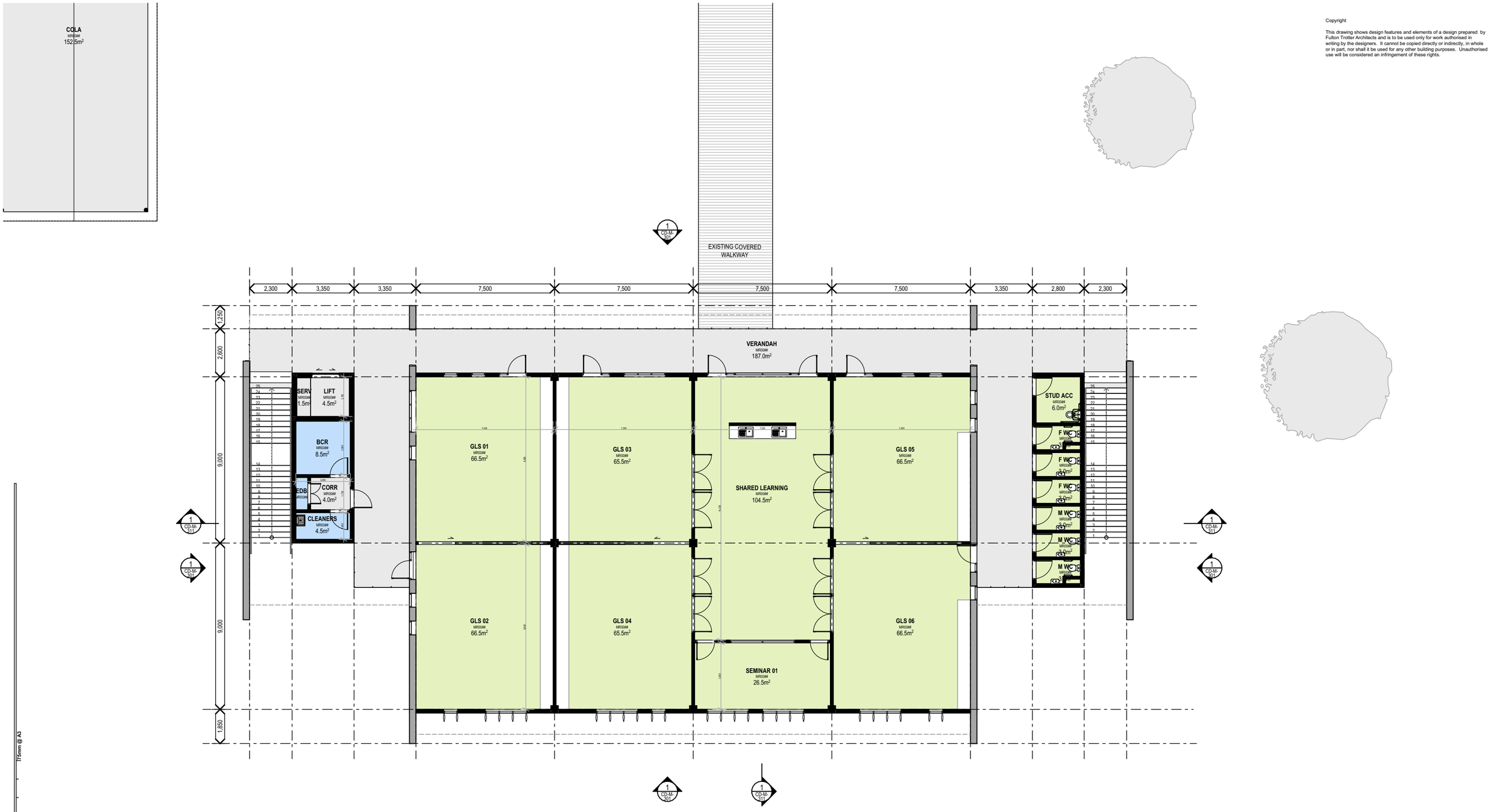
ADDRESS Captain Cook Dr
Cronulla, NSW

DRAWING **Block M - Ground Floor Plan**

Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

PROJECT NUMBER	DIRECTOR	CHECKED
7068CR01	JW	

DRAWING NUMBER	REVISION
CD-M-201	K



REV.	DESCRIPTION	DATE	INIT.
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C	Preliminary Issue	23/03/21	LW
D	Preliminary Issue	08/04/21	LW
E	User Workshop	14/04/21	LW
F	Coordination Issue	05/05/21	JH
G	Coordination Issue	08/06/21	LW
H	Co-ordination Issue	30/06/21	LW
I	Co-ordination Issue	12/07/21	LW

0 0.5 1 2 3 Scale 1:100 @ A3 5m

25 50 75mm @ A3

plot date: Monday, 12 July 2021 file location: BIMcloud: SYDBIM23 - BIMcloud Basic for ARCHICAD 23/7068CR01 - Cronulla HS - CONCEPT DESIGN

fulton trotter ARCHITECTS

SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022

t. (02) 8383 5151
e. sydney@fultontrotter.com.au

BRISBANE
SYDNEY

DIRECTORS

Greg Isaac raia		NSW 6855	QLD 2920
Justine Ebzery raia			QLD 3313
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Ryan Loveday raia			QLD 4500

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CLIENT NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)

PROJECT CRONULLA HIGH SCHOOL

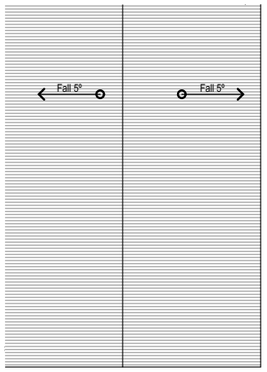
ADDRESS Captain Cook Dr
Cronulla, NSW

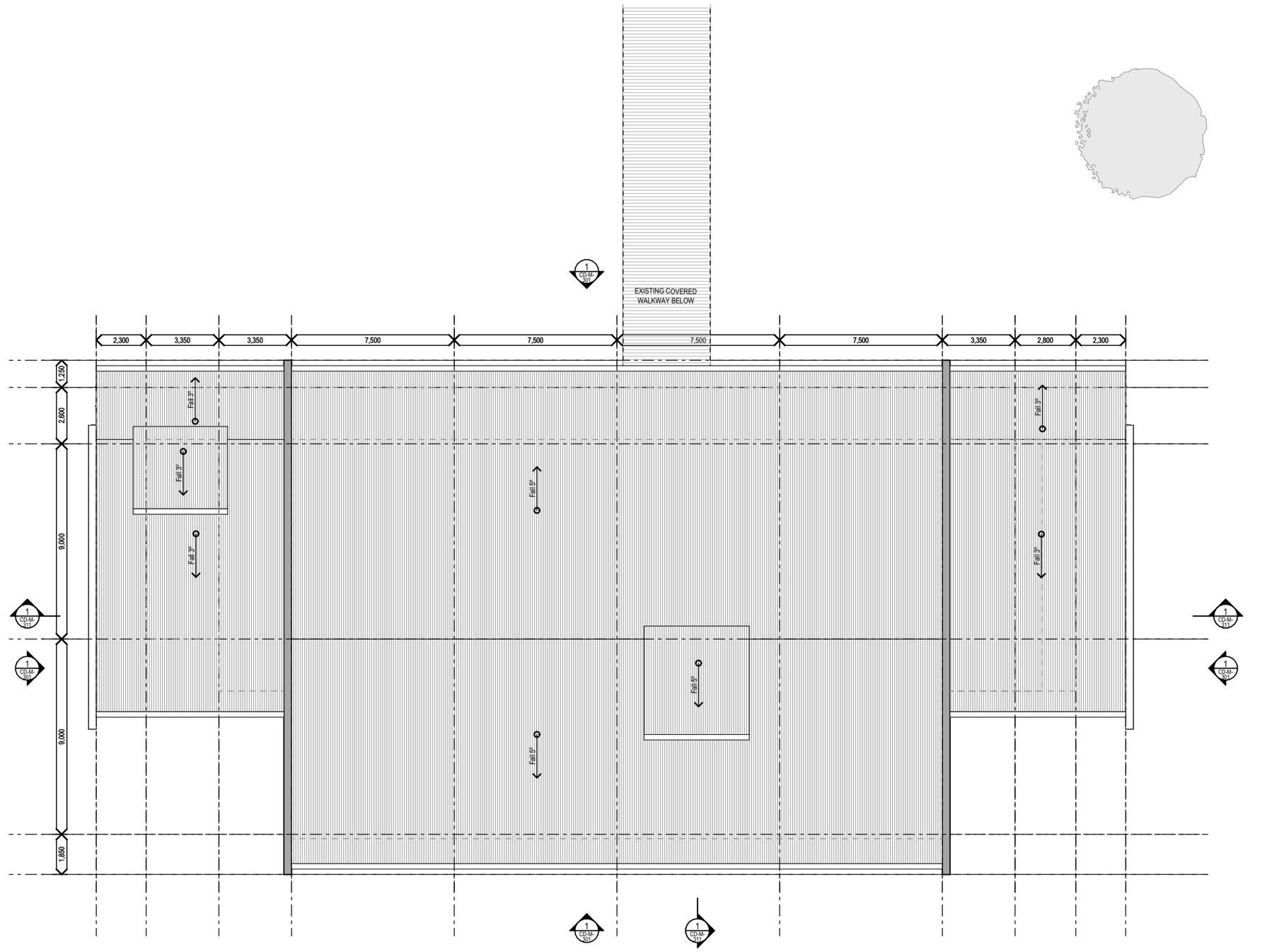
DRAWING **Block M - First Floor Plan**

Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

PROJECT NUMBER	DIRECTOR	CHECKED
7068CR01	JW	

DRAWING NUMBER **CD-M-202** REVISION **I**





REV.	DESCRIPTION	DATE	INIT.
A	EFSG REVIEW	10/02/21	LW
B	USER GROUP WORKSHOP	15/02/21	LW
C	Preliminary Issue	18/03/21	LW
D	Preliminary Issue	23/03/21	LW
E	Preliminary Issue	08/04/21	LW
F	User Workshop	14/04/21	LW
G	Coordination Issue	05/05/21	JH
H	Coordination Issue	08/06/21	LW
I	Co-ordination Issue	30/06/21	LW
J	Co-ordination Issue	12/07/21	LW

0 0.5 1 2 3 Scale 1:100 @ A3 5m

25 50 75mm @ A3

175mm @ A3 | 50 | 25

plot date: Monday, 12 July 2021 file location: BIMcloud: SYDBIM23 - BIMcloud Basic for ARCHICAD 23/7068CR01 - Cronulla HS - CONCEPT DESIGN

fulton trotter ARCHITECTS

SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022

t. (02) 8383 5151
e. sydney@fultontrotter.com.au

BRISBANE
SYDNEY

DIRECTORS

Greg Isaac raia		NSW 6855	QLD 2920
Justine Ebzery raia			QLD 3313
John Ward raia	VIC 18804	NSW 8371	QLD 3847
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Paul Sekava raia		NSW 7180	QLD 3108
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CLIENT NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)

PROJECT CRONULLA HIGH SCHOOL

ADDRESS Captain Cook Dr
Cronulla, NSW

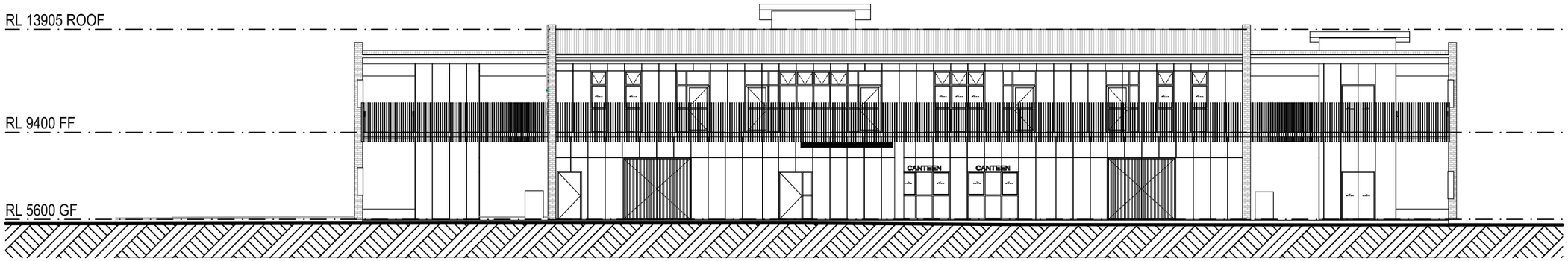
DRAWING **Block M - Roof Plan**

Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

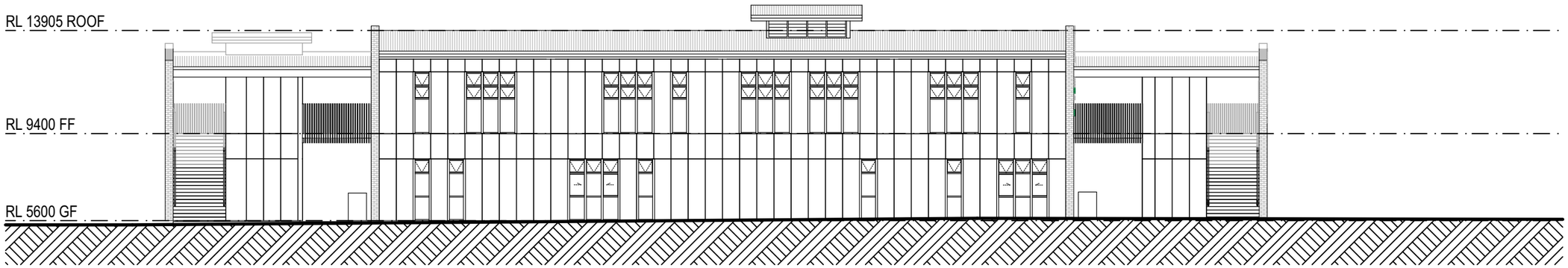
PROJECT NUMBER	DIRECTOR	CHECKED
7068CR01	JW	

DRAWING NUMBER **CD-M-203**

REVISION **J**



NORTHERN ELEVATION - BUILDING M
SCALE: 1:200



SOUTHERN ELEVATION - BUILDING M
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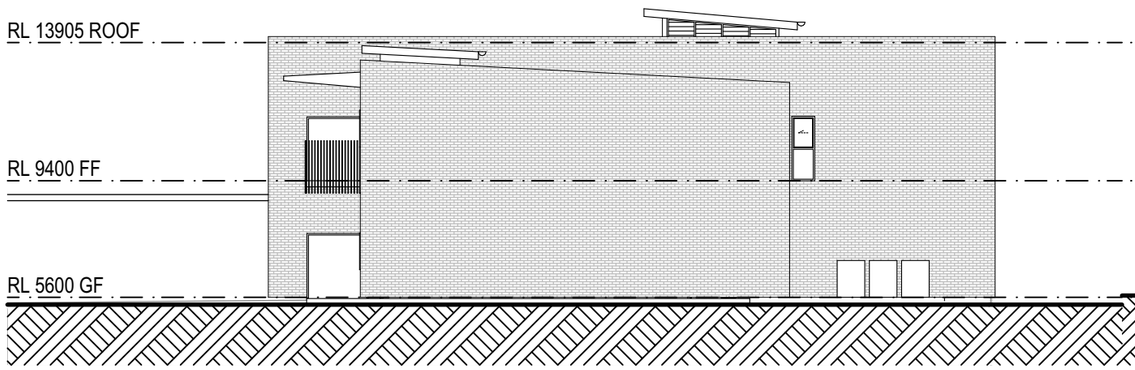
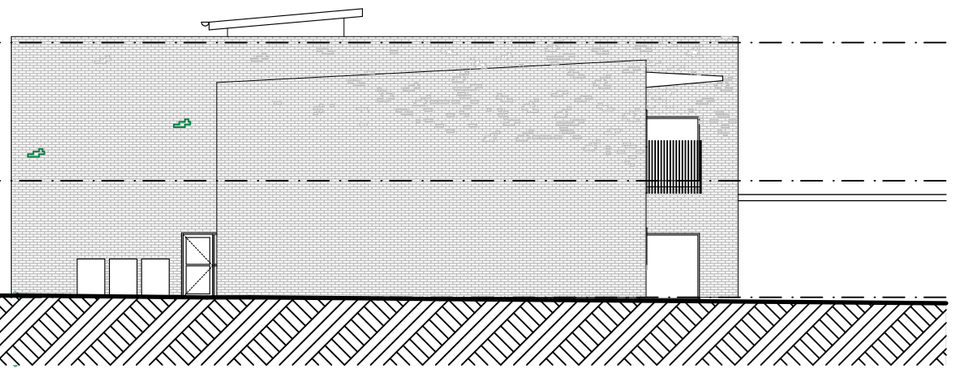


WESTERN ELEVATION - BUILDING M
SCALE: 1:200



EASTERN ELEVATION - BUILDING M
SCALE: 1:200

REV.	DESCRIPTION	DATE	INIT.
A	Coordination Issue	08/06/21	LW
B	Co-ordination Issue	30/06/21	LW
C	Co-ordination Issue	12/07/21	LW

0 1 2 4 6 Scale 1:200 @ A3 10m

25 50 75mm @ A3

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fulton trotter
ARCHITECTS
SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022
t. (02) 8383 5151
e. sydney@fultontrotter.com.au
BRISBANE
SYDNEY

DIRECTORS

Greg Isaac raia		NSW 6855	QLD 2920
Justine Elszery raia			QLD 3313
John Ward raia	VIC 18804	NSW 8371	QLD 3847
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PHASE: **CONCEPT DESIGN**

CLIENT: NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)

PROJECT: CRONULLA HIGH SCHOOL

ADDRESS: Captain Cook Dr
Cronulla, NSW

DRAWING: **Block M - Elevations 01**

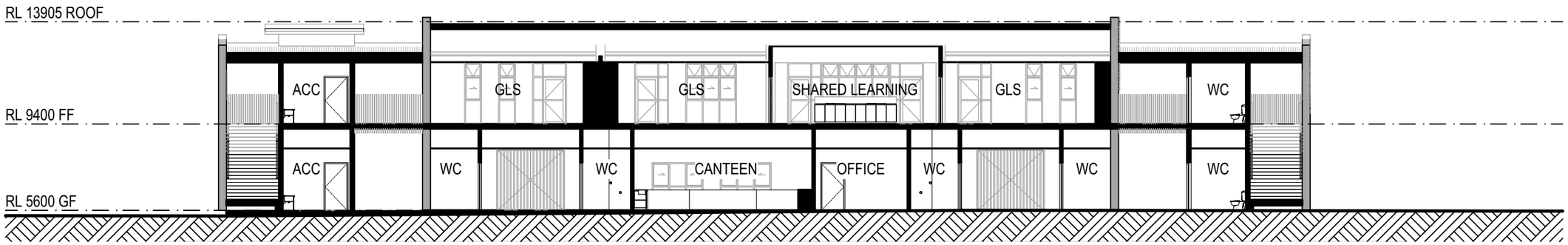
Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

PROJECT NUMBER	DIRECTOR	CHECKED
7068CR01	JW	

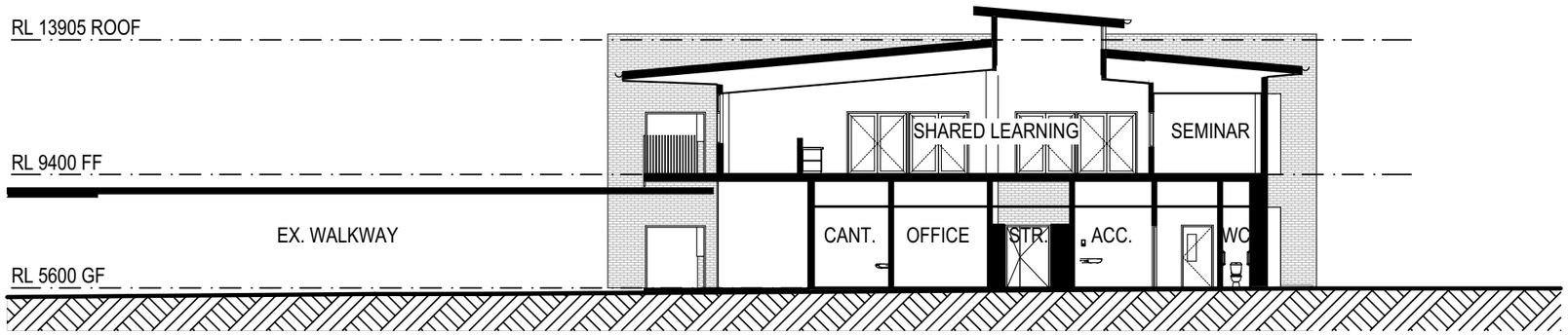
DRAWING NUMBER: **CD-M-301**

REVISION: **C**

175mm @ A3



SECTION 01 - BUILDING M
SCALE: 1:200



SECTION 02 - BUILDING M
SCALE: 1:200

BUILDING M - OFF CENTRAL COURTYARD

BUILDING M - REAR LANEWAY

REV.	DESCRIPTION	DATE	INIT.
A	Coordination Issue	08/06/21	LW
B	Co-ordination Issue	30/06/21	LW
C	Co-ordination Issue	12/07/21	LW

0 1 2 4 6 Scale 1:200 @ A3 10m

175mm @ A3 | 50 | 25 | 25 | 50 | 75mm @ A3

plot date: Monday, 12 July 2021 file location: BIMcloud: SYDBIM23 - BIMcloud Basic for ARCHICAD 23/7068CR01 - Cronulla HS - CONCEPT DESIGN

fulton trotter ARCHITECTS
SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022
t. (02) 8383 5151
e. sydney@fultontrotter.com.au
BRISBANE
SYDNEY

DIRECTORS

Greg Isaac raia		NSW 6855	QLD 2920
Justine Elszery raia			QLD 3313
John Ward raia	VIC 18804	NSW 8371	QLD 3847
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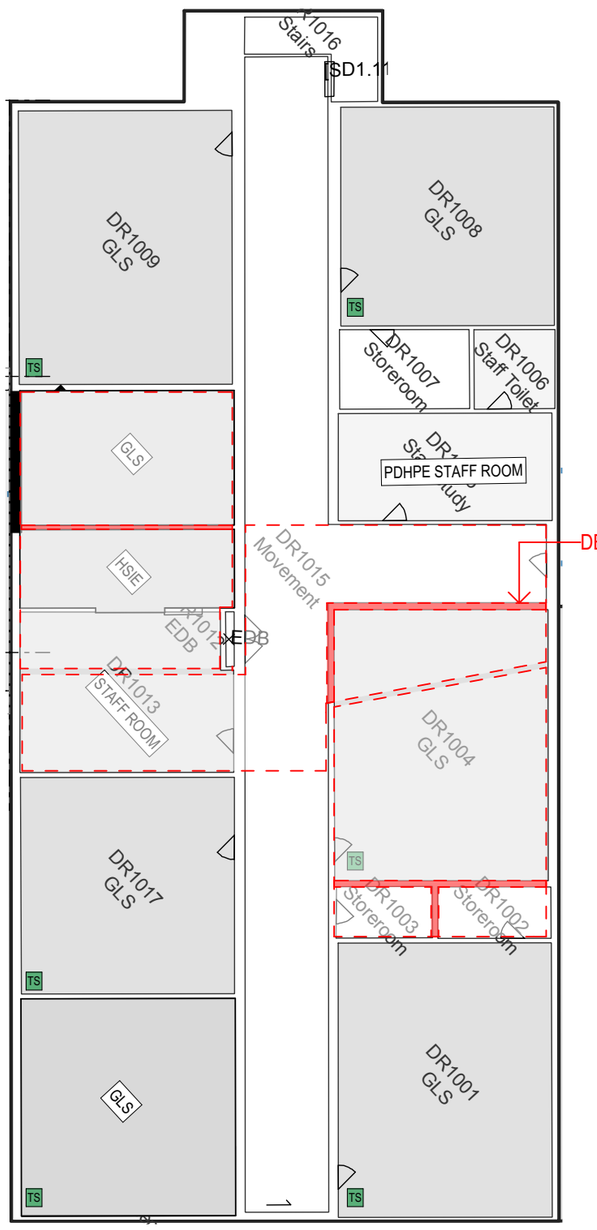
PHASE: **CONCEPT DESIGN**
CLIENT: NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)
PROJECT: CRONULLA HIGH SCHOOL
ADDRESS: Captain Cook Dr Cronulla, NSW

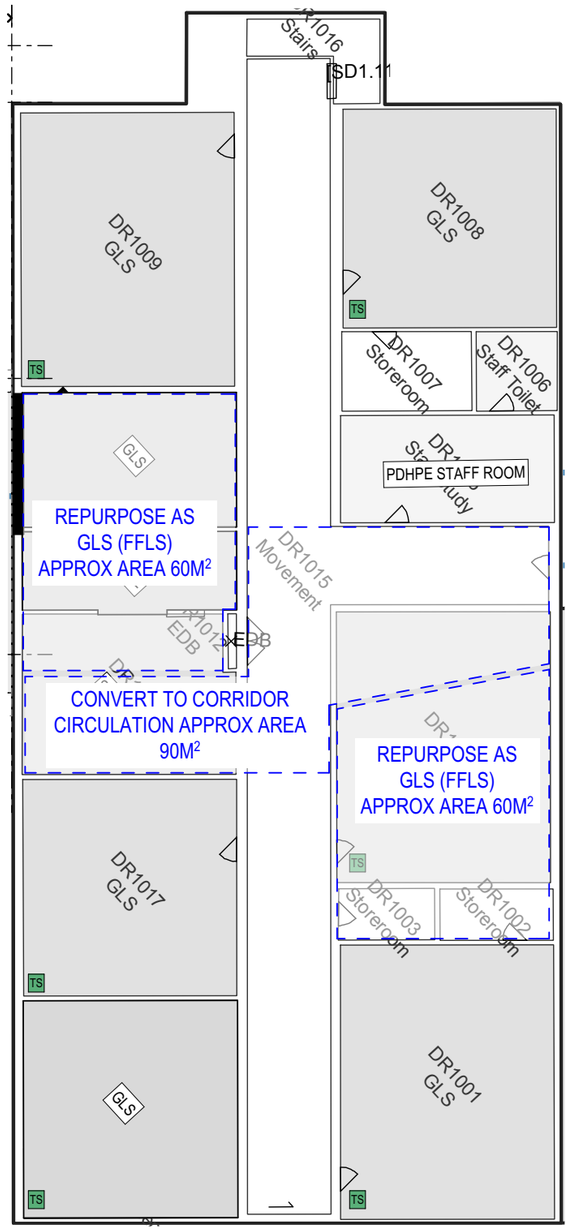
DRAWING: **Block M - Sections 01**

Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

PROJECT NUMBER: **7068CR01**
DIRECTOR: **JW**
CHECKED:
DRAWING NUMBER: **CD-M-311**
REVISION: **C**



FIRST FLOOR PLAN - BUILDING D (EXISTING/DEMO)
SCALE: 1:200



FIRST FLOOR PLAN - BUILDING D (PROPOSED)
SCALE: 1:200

REV.	DESCRIPTION	DATE	INIT.
A	Preliminary Issue	18/03/21	LW
B	User Workshop	14/04/21	LW
C	Coordination Issue	05/05/21	JH
D	Coordination Issue	08/06/21	LW

0 0.5 1 2 3 Scale 1:100 @ A3 5m

0 1 2 4 6 Scale 1:200 @ A3 10m

175mm @ A3 | 50 | 125 | 25 | 50 | 75mm @ A3

plot date: Tuesday, 8 June 2021 file location: BIMcloud: SYDBIMSYD - BIMcloud Basic for ARCHICAD 23/7068CR01 - Cronulla HS - CONCEPT DESIGN

fulton trotter ARCHITECTS
SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022
t. (02) 8383 5151
e. sydney@fultontrotter.com.au
BRISBANE
SYDNEY

DIRECTORS
Greg Isaac raia NSW 6855 QLD 2920
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PHASE: **CONCEPT DESIGN**

CLIENT: NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)

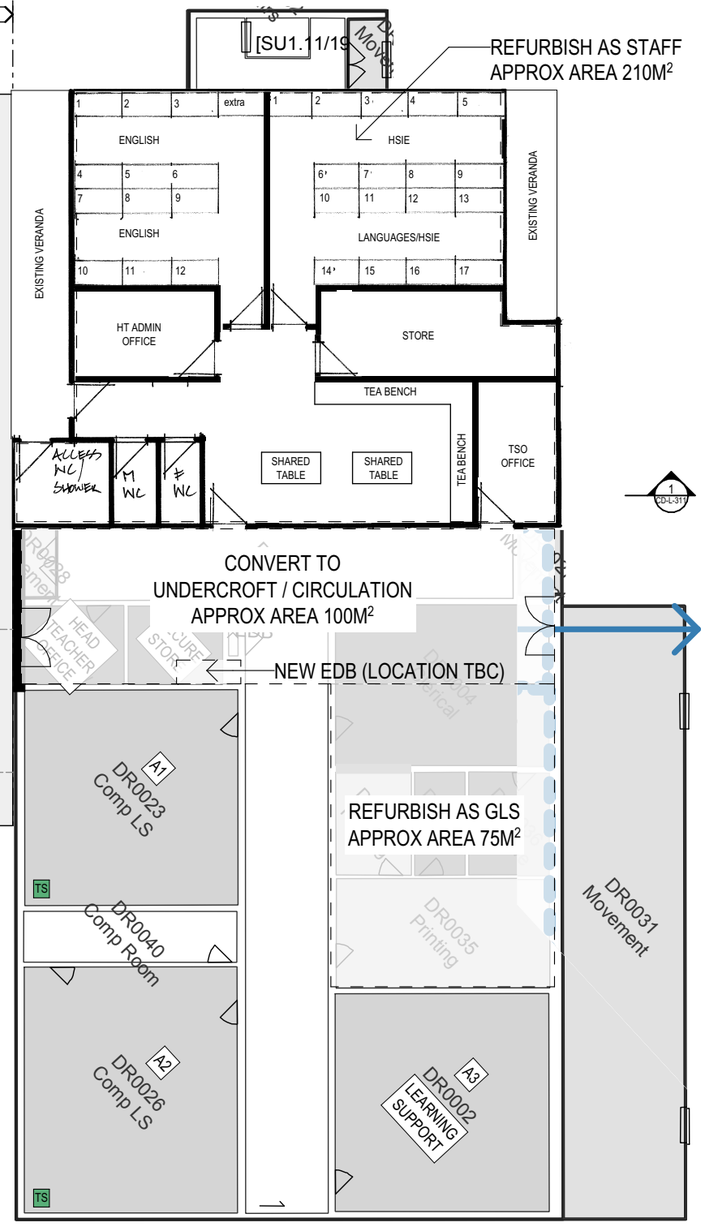
PROJECT: CRONULLA HIGH SCHOOL

ADDRESS: Captain Cook Dr
Cronulla, NSW

DRAWING: **Block D - First Floor Plan**

Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

PROJECT NUMBER: **7068CR01**
DIRECTOR: **JW**
CHECKED:
DRAWING NUMBER: **CD-D-202**
REVISION: **D**



REV.	DESCRIPTION	DATE	INIT.
A	EFSG REVIEW	10/02/21	LW
B	EFSG REVIEW	12/02/21	LW
C	USER GROUP WORKSHOP	15/02/21	LW
D	USER GROUP WORKSHOP	10/03/21	LW
E	Preliminary Issue	18/03/21	LW
F	Preliminary Issue	23/03/21	LW
G	Preliminary Issue	08/04/21	LW
H	User Workshop	14/04/21	LW
I	Preliminary Issue	16/04/21	LW
J	Coordination Issue	05/05/21	JH
K	Coordination Issue	08/06/21	LW

0 1 2 4 6 Scale 1:200 @ A3 10m

25 50 75mm @ A3

plot date: Tuesday, 8 June 2021 file location: BIMcloud: SYDBIMSYD - BIMcloud Basic for ARCHICAD 23/7068CR01 - Cronulla HS - CONCEPT DESIGN

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SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022

t. (02) 8383 5151
e. sydney@fultontrotter.com.au

BRISBANE
SYDNEY

DIRECTORS
Greg Isaac raia NSW 6855 QLD 2920
Justine Ebzery raia QLD 3313
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Paul Trotter fraia NSW 7177 QLD 2646
Ryan Loveday raia QLD 4500

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PHASE: **CONCEPT DESIGN**

CLIENT: NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)

PROJECT: CRONULLA HIGH SCHOOL

ADDRESS: Captain Cook Dr
Cronulla, NSW

DRAWING: **Block L - Ground Floor Plan**

Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

PROJECT NUMBER: **7068CR01**
DIRECTOR: **JW**
CHECKED:
DRAWING NUMBER: **CD-L-201**
REVISION: **K**

REV.	DESCRIPTION	DATE	INIT.
A	EFSG REVIEW	10/02/21	LW
B	USER GROUP WORKSHOP	10/03/21	LW
C	Preliminary Issue	18/03/21	LW
D	Preliminary Issue	23/03/21	LW
E	Preliminary Issue	08/04/21	LW
F	User Workshop	14/04/21	LW
G	Coordination Issue	05/05/21	JH
H	Coordination Issue	08/06/21	LW

0 1 2 4 6 Scale 1:200 @ A3 10m

175mm @ A3 | 50 | 25

plot date: Tuesday, 8 June 2021 file location: BIMcloud: SYDBIMSYD - BIMcloud Basic for ARCHICAD 23/7068CR01 - Cronulla HS - CONCEPT DESIGN

fulton trotter ARCHITECTS

SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022

t. (02) 8383 5151
e. sydney@fultontrotter.com.au

BRISBANE
SYDNEY

DIRECTORS
Greg Isaac raia NSW 6855 QLD 2920
Justine Ebzery raia QLD 3313
John Ward raia VIC 18804 NSW 8371 QLD 3847
Katerina Dracopoulos raia QLD 4529
Mark Trotter fraia VIC 17691 NSW 4421 QLD 1870
Paul Sekava raia NSW 7180 QLD 3108
Paul Trotter fraia NSW 7177 QLD 2646
Ryan Loveday raia QLD 4500

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PHASE: CONCEPT DESIGN

CLIENT: NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)

PROJECT: CRONULLA HIGH SCHOOL

ADDRESS: Captain Cook Dr
Cronulla, NSW

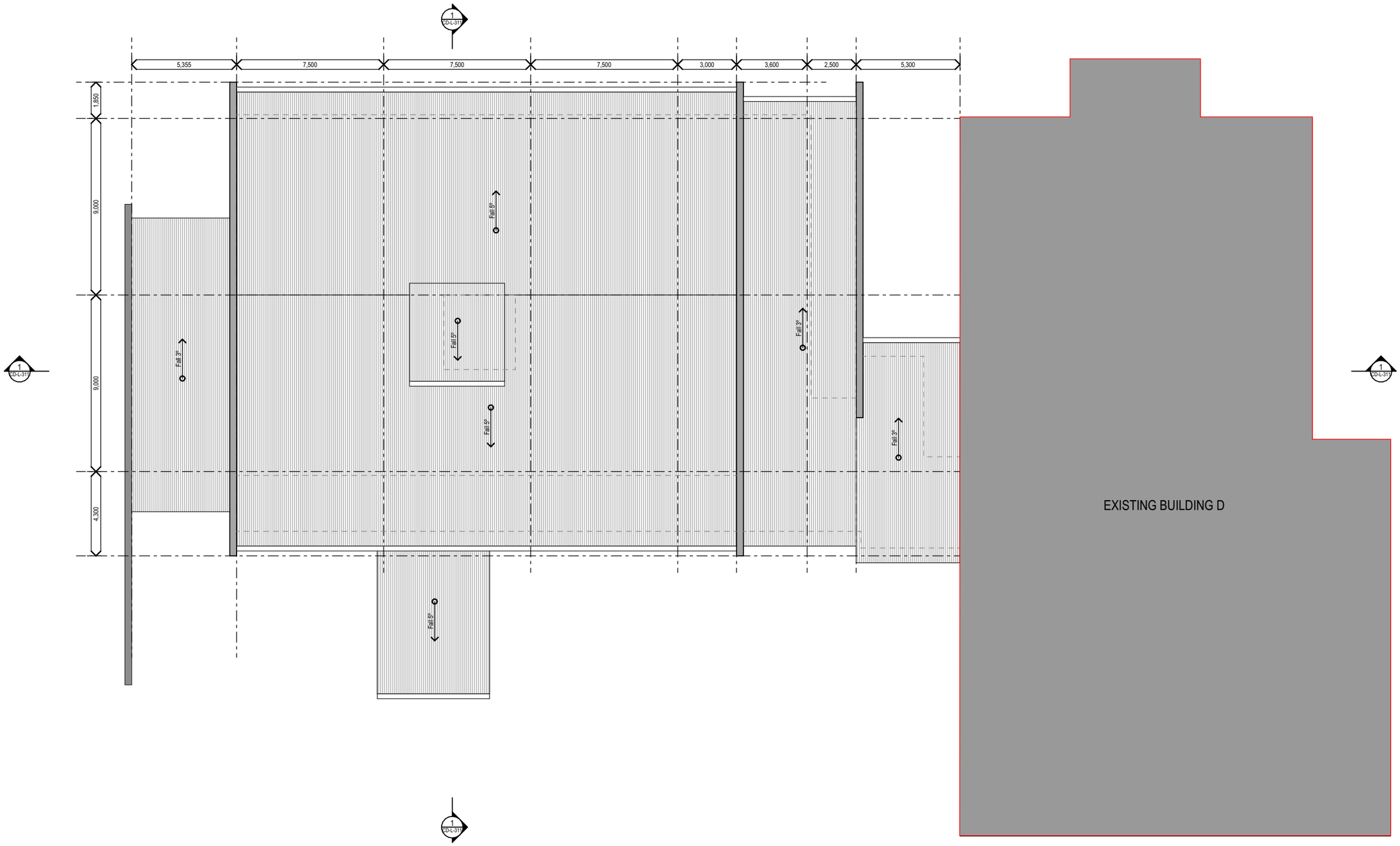
DRAWING: Block L - First Floor Plan

Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

PROJECT NUMBER	DIRECTOR	CHECKED
7068CR01	JW	

DRAWING NUMBER: CD-L-202

REVISION: H



REV.	DESCRIPTION	DATE	INIT.
A	EFSG REVIEW	10/02/21	LW
B	Preliminary Issue	08/04/21	LW
C	User Workshop	14/04/21	LW
D	Coordination Issue	05/05/21	JH
E	Coordination Issue	08/06/21	LW

0 1 2 4 6 Scale 1:200 @ A3 10m

175mm @ A3 | 50 | 25

25 50 75mm @ A3

plot date: Tuesday, 8 June 2021 file location: BIMcloud: SYDBIMSYD - BIMcloud Basic for ARCHICAD 23/7068CR01 - Cronulla HS - CONCEPT DESIGN

fulton trotter ARCHITECTS

SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022

t. (02) 8383 5151
e. sydney@fultontrotter.com.au

BRISBANE
SYDNEY

DIRECTORS

Greg Isaac raia		NSW 6855	QLD 2920
Justine Elszery raia			QLD 3313
John Ward raia	VIC 18804	NSW 8371	QLD 3847
Katerina Dracopoulos raia			QLD 4529
Mark Trotter fraia	VIC 17691	NSW 4421	QLD 1870
Paul Sekava raia		NSW 7180	QLD 3108
Paul Trotter fraia		NSW 7177	QLD 2646
Ryan Loveday raia			QLD 4500

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PHASE: **CONCEPT DESIGN**

CLIENT: NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)

PROJECT: CRONULLA HIGH SCHOOL

ADDRESS: Captain Cook Dr
Cronulla, NSW

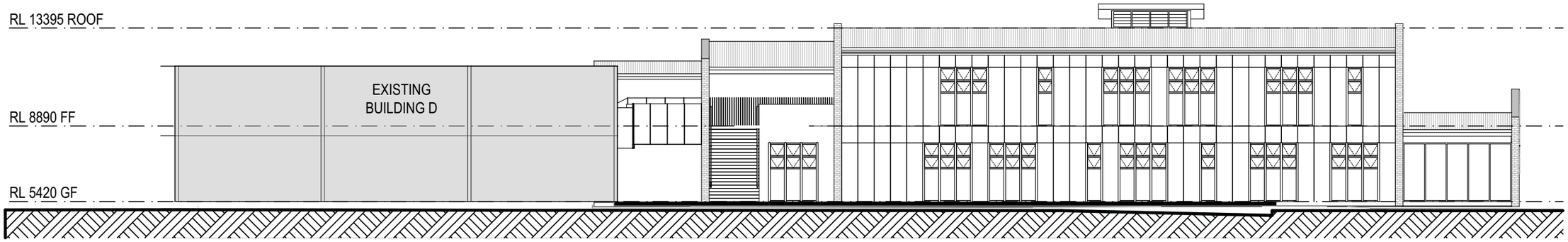
DRAWING: **Block L - Roof Plan**

Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

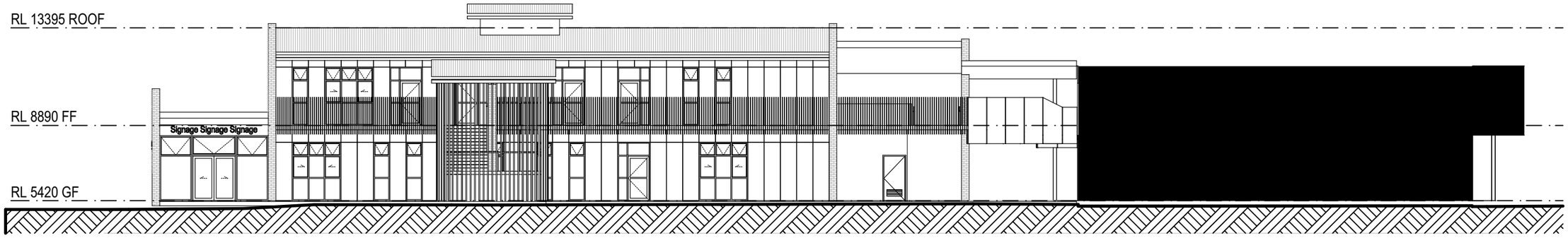
PROJECT NUMBER	DIRECTOR	CHECKED
7068CR01	JW	

DRAWING NUMBER: **CD-L-203**

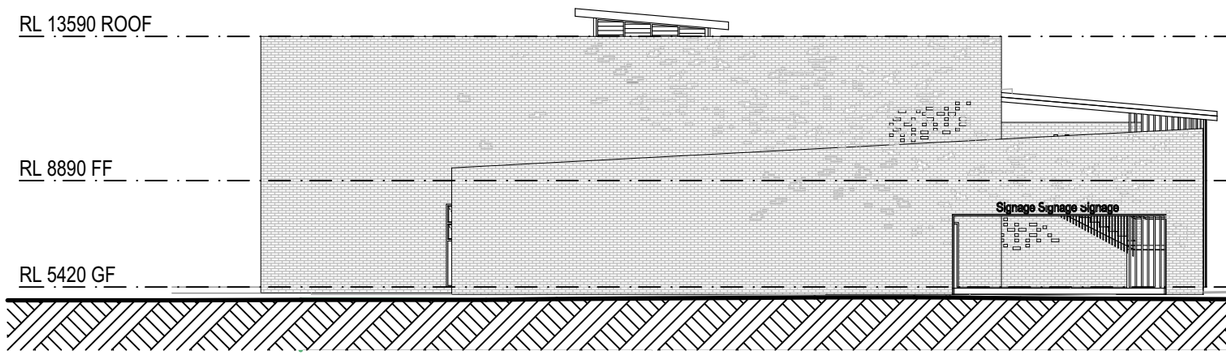
REVISION: **E**



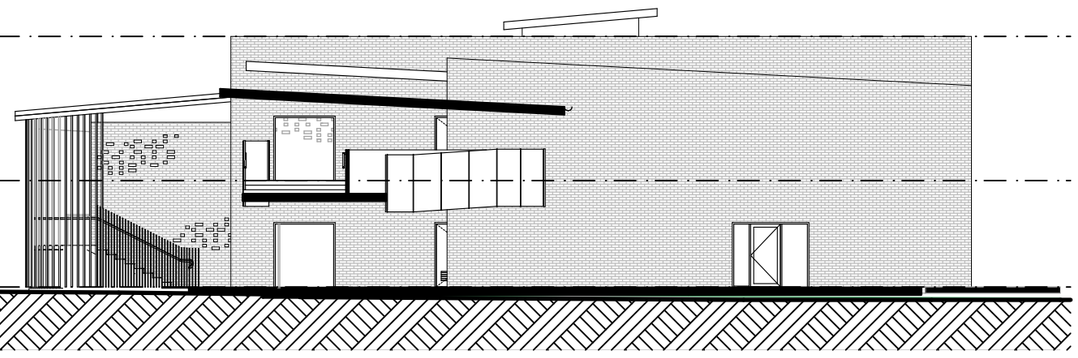
NORTHERN ELEVATION - BUILDING L
SCALE: 1:200



SOUTHERN ELEVATION - BUILDING L
SCALE: 1:200



WESTERN ELEVATION - BUILDING L
SCALE: 1:200



EASTERN ELEVATION - BUILDING L
SCALE: 1:200

REV.	DESCRIPTION	DATE	INIT.
A	Coordination Issue	08/06/21	LW

0 1 2 4 6 Scale 1:200 @ A3 10m

175mm @ A3 | 25 | 50 | 75mm @ A3

fulton trotter ARCHITECTS
SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022
t. (02) 8383 5151
e. sydney@fultontrotter.com.au
BRISBANE
SYDNEY

DIRECTORS

Greg Isaac raia		NSW 6855	QLD 2920
Justine Ebzery raia			QLD 3313
John Ward raia	VIC 18804	NSW 8371	QLD 3847
Katerina Dracopoulos raia			QLD 4529
Mark Trotter raia	VIC 17691	NSW 4421	QLD 1870
Paul Sekava raia		NSW 7180	QLD 3108
Paul Trotter fraia		NSW 7177	QLD 2646
Ryan Loveday raia			QLD 4500

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PHASE: **CONCEPT DESIGN**

CLIENT: NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)

PROJECT: CRONULLA HIGH SCHOOL

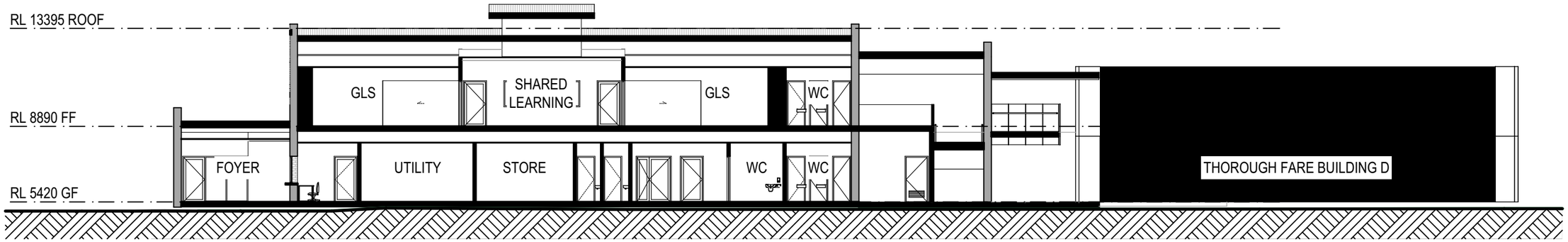
ADDRESS: Captain Cook Dr
Cronulla, NSW

DRAWING: **Block L - Elevations 01**

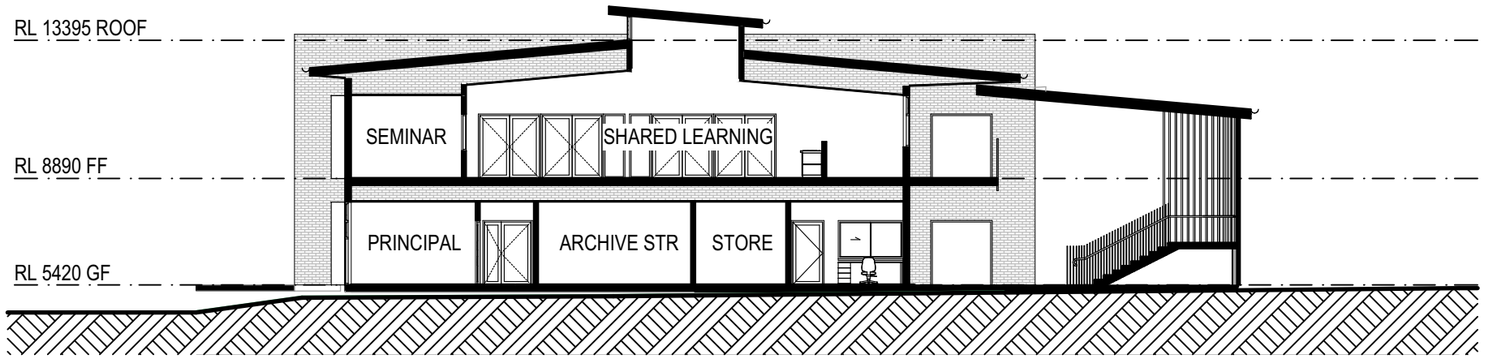
Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

PROJECT NUMBER	DIRECTOR	CHECKED
7068CR01	JW	

DRAWING NUMBER	REVISION
CD-L-301	A



SECTION 01 - BUILDING L
SCALE: 1:200



SECTION 02 - BUILDING L
SCALE: 1:200

PERSPECTIVE 01 - BUILDING L
SCALE: 1:250

PERSPECTIVE 02 - BUILDING L
SCALE: 1:250

REV.	DESCRIPTION	DATE	INIT.
A	Coordination Issue	08/06/21	LW

0 1 2 4 6 Scale 1:200 @ A3 10m

25 50 75mm @ A3

plot date: Tuesday, 8 June 2021 file location: BIMcloud: SYDBIMSYD - BIMcloud Basic for ARCHICAD 23/7068CR01 - Cronulla HS - CONCEPT DESIGN

fulton trotter ARCHITECTS

SYDNEY
Level 3, 35 Spring Street
PO Box 1669
Bondi Junction, NSW 2022

t. (02) 8383 5151
e. sydney@fultontrotter.com.au

BRISBANE
SYDNEY

DIRECTORS

Greg Isaac raia		NSW 6855	QLD 2920
Justine Ebzery raia			QLD 3313
John Ward raia	VIC 18804	NSW 8371	QLD 3847
Katerina Dracopoulos raia			QLD 4529
Mark Trotter raia	VIC 17691	NSW 4421	QLD 1870
Paul Jelkeya raia		NSW 7180	QLD 3108
Paul Trotter fraia		NSW 7177	QLD 2646
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PHASE **CONCEPT DESIGN**

CLIENT NSW DEPARTMENT OF EDUCATION (SCHOOLS INFRASTRUCTURE)

PROJECT CRONULLA HIGH SCHOOL

ADDRESS Captain Cook Dr
Cronulla, NSW

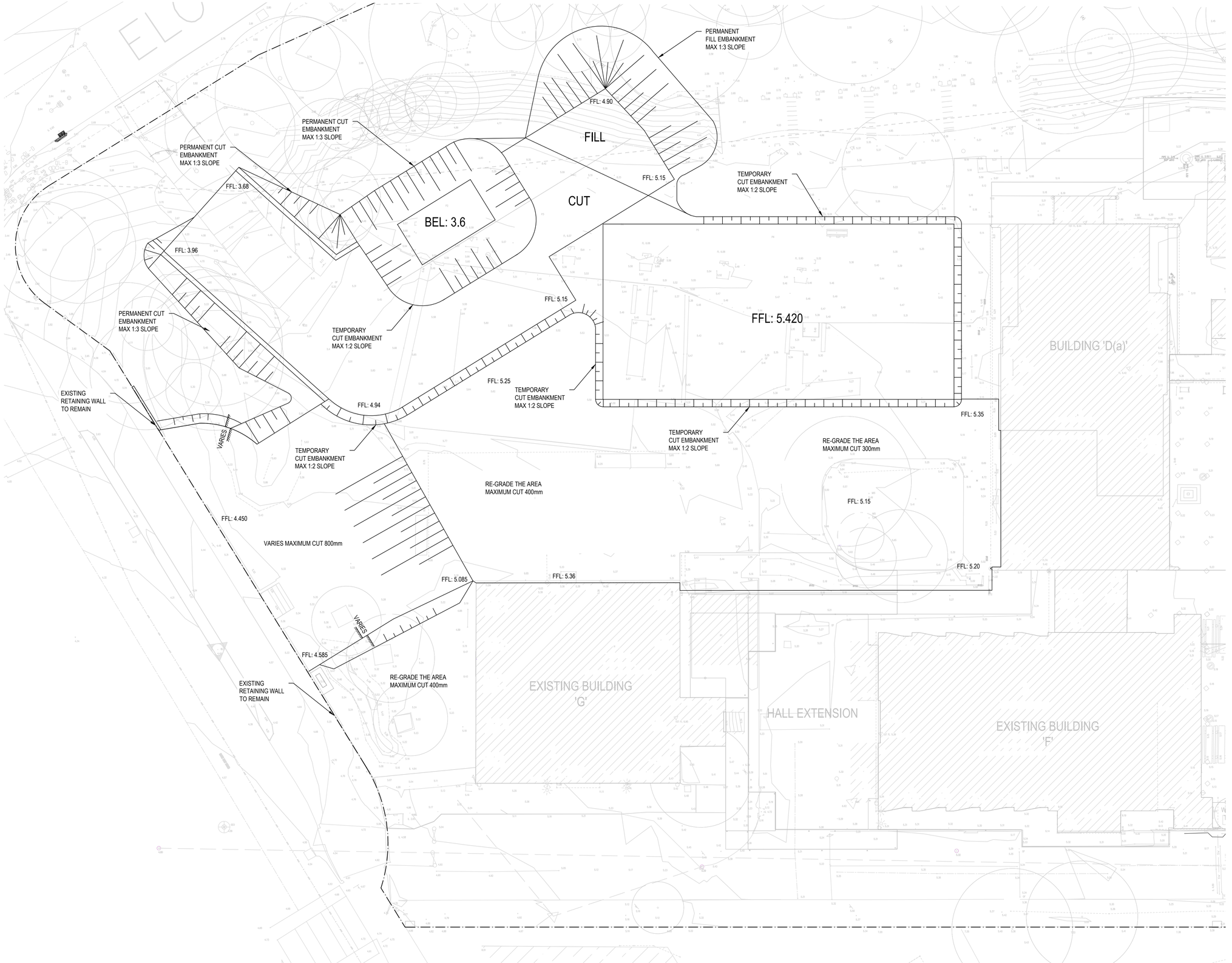
DRAWING **Block L - Sections 01**

Figured dimensions take precedence over scale dimensions. Contractors must verify all dimensions on site before commencing any work or making shop drawings.

PROJECT NUMBER	DIRECTOR	CHECKED
7068CR01	JW	

DRAWING NUMBER	REVISION
CD-L-311	A

11 Attachment C – Cut Fill Plans (Cardno, 2022)



FOR CONTINUATION REFER TO DRAWING CI-0108

Rev.	Date	Description	Des.	Verif.	Appd.
1	05/07/2022	INDICATIVE EXTENT OF EARTHWORKS	VJ	VJ	PP

Cardno (NSW/ACT) Pty Ltd | ABN 95 001 145 035
Level 9, The Forum, 203 Pacific Highway
St. Leonards, NSW 2065
Tel: 02 9496 7700 Fax: 02 9439 5170
Web: www.cardno.com.au

Drawn	GM	Date MAY 2022
Checked	MR	Date MAY 2022
Designed	VJ	Date MAY 2022
Verified	PP	Date MAY 2022
Approved		

Client: NSW DEPARTMENT OF EDUCATION

Project: CRONULLA HIGH SCHOOL
CAPTAIN COOK DRIVE, CRONULLA NSW

Title: CIVIL
BULK EXCAVATION PLAN
SHEET 1

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

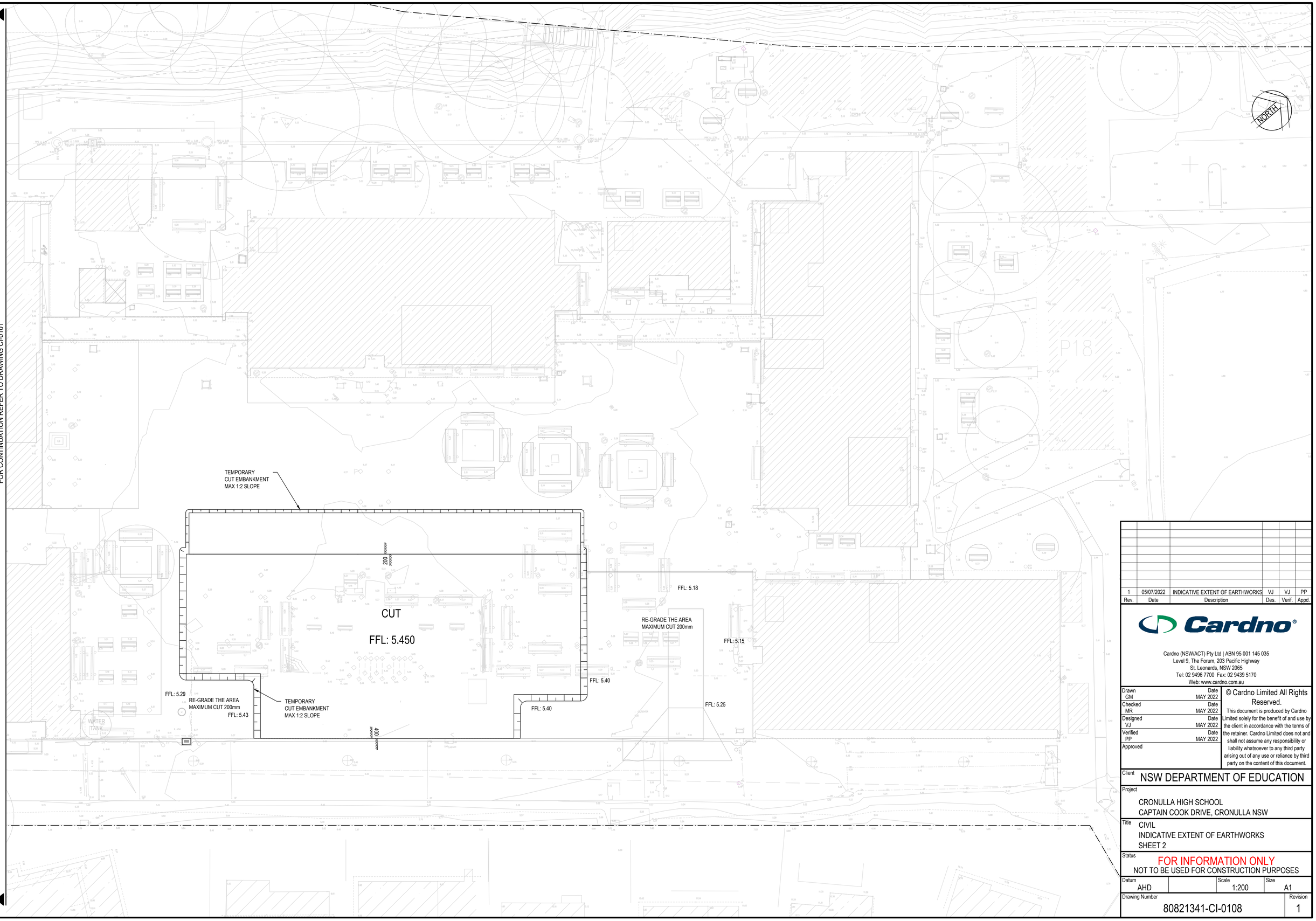
Datum		Scale	Size
AHD		1:200	A1

Drawing Number: 80821341-CI-0107

Revision: 1

DATE PLOTTED: 5 July 2022 11:26 AM BY - GORAN MILENKOVIC

FOR CONTINUATION REFER TO DRAWING CI-0101



Rev.	Date	Description	Des.	Verif.	Appd.
1	05/07/2022	INDICATIVE EXTENT OF EARTHWORKS	VJ	VJ	PP

Cardno (NSW/ACT) Pty Ltd | ABN 95 001 145 035
Level 9, The Forum, 203 Pacific Highway
St. Leonards, NSW 2065
Tel: 02 9496 7700 Fax: 02 9439 5170
Web: www.cardno.com.au

Drawn	GM	Date MAY 2022
Checked	MR	Date MAY 2022
Designed	VJ	Date MAY 2022
Verified	PP	Date MAY 2022
Approved		

Client: NSW DEPARTMENT OF EDUCATION

Project: CRONULLA HIGH SCHOOL
CAPTAIN COOK DRIVE, CRONULLA NSW

Title: CIVIL
INDICATIVE EXTENT OF EARTHWORKS
SHEET 2

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

Datum		Scale	Size
AHD		1:200	A1

Drawing Number	Revision
80821341-CI-0108	1

XREFs: X-Survey; X-ARCH-GROUND FLOOR PLAN

CAD File: N:\Projects\80\8\FY21341_Cronulla HS-Phase 2 to 6\01\2_CIVIL\Drawings\Build\80821341-CI-0108.dwg

12 Attachment D – Summary of Subsurface Conditions

Table D1: Summary of subsurface units within CPT01 to CPT07.

Units	Material	Depth (mbgl)						
		CPT01 (5.4 mAHD)	CPT02 (5.2 mAHD)	CPT03 (5.3 mAHD)	CPT04 (5.2 mAHD)	CPT05 (5.5 mAHD)	CPT06 (5.3 mAHD)	CPT07 (5.2 mAHD)
Unit A	FILL	NE [2]	NE [2]	NE [2]	NE [2]	0.0 – 0.3	0.0 – 0.75	0.0 – 0.8
Unit B	TOPSOIL	NE [2]	NE [2]	NE [2]	NE [2]	NE [2]	NE [2]	NE [2]
Unit C1	MARINE: SAND (loose) [2]	NE [3]	0.0 – 4.75	0.0 – 4.8	0.0 – 0.5	0.3 – 4.8	0.75 – 4.4 & 10.8 – 11.5	0.8 – 4.8 & 11.0 – 13.25
Unit C2	MARINE: SAND (medium dense)	0.0 – 5.2 & 8.0 – 9.0	NE [2]	4.8 – 6.0	0.5 – 5.6	4.8 – 6.2	NE [2]	4.8 – 6.0
Unit C3	MARINE: SAND (dense to very dense)	5.2 – 8.0 & 9.0 – 9.91 [1]	4.75 – 7.4 [1]	6.0 – 7.9 [1]	5.6 – 7.6 [1]	6.2 – 7.74 [1]	4.4 – 10.8 & 11.5 – 14.86 [1]	6.0 – 11.0 & 13.25 – 14.6 [1]

Notes:

1. CPT termination depth.
2. Not encountered.

Table D2: Summary of subsurface units within BH101 to BH110.

Units	Material	Depth (mbgl)									
		BH101 (5.32 mAHD)	BH102 (5.4 mAHD)	BH103 (5.12 mAHD)	BH104 (5.43 mAHD)	BH105 (5.2 mAHD)	BH106 (5.29 mAHD)	BH107 (5.29 mAHD)	BH108 (2.41 mAHD)	BH109 (2.83 mAHD)	BH110 (5.2 mAHD)
Unit A	FILL	NE [3]	0.0 – 0.4	0.0 – 1.2	0.0 – 1.2	0.0 – 1.3	NE [3]	NE [3]	NE [3]	0.0 – 1.1	0.0 – 3.7
Unit B	TOPSOIL	NE [3]	NE [3]	NE [3]	NE [3]	NE [3]	NE [3]	NE [3]	0.0 – 0.3	NE [3]	NE [3]
Unit C1	MARINE: SAND (loose) [2]	0.0 – 4.1	0.4 – 3.2	1.2 – 2.4	1.2 – 4.7	1.3 – 2.9	0.0 – 2.4	0.0 – 3.0	NE [3]	1.1 – 2.6 [1]	3.7 – 4.2 [1]
Unit C2	MARINE: SAND (medium dense)	4.1 – 5.1	3.2 – 5.1	2.4 – 3.3	4.7 – 5.1	2.9 – 5.4	2.4 – 4.1	3.0 – 3.7	0.3 – 1.7	NA [4]	NA [4]
Unit C3	MARINE: SAND (dense to very dense)	5.1 – 10.0 [1]	5.1 – 10.0 [1]	3.3 – 10.0 [1]	5.1 – 7.0 [1]	5.4 – 7.0 [1]	4.1 – 7.0 [1]	3.7 – 7.0 [1]	1.7 – 4.2 [1]	NA [4]	NA [4]

Notes:

1. Borehole termination depth.
2. Contains interbedded medium dense sand at some locations.
3. Not encountered.
4. Not applicable.

13 Attachment E – Borehole Logs

CLIENT	NSW Department of Education c/- SINSW		COMMENCED	22/05/2021	COMPLETED	22/05/2021	**REF BH101**
PROJECT	Geotechnical Assessment		LOGGED	AG	CHECKED	KB	Sheet 1 OF 1
SITE	Cronulla High School		GEOLOGY	Quaternary Deposits	VEGETATION	None	PROJECT NO. 2108205
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	151.15831	RL SURFACE	5.32 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 10.00 m depth	LATITUDE	-34.0392	ASPECT	Southeast	SLOPE < 5 %

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	H			5.22	0.1-0.2/S/1 D 0.10 m			SP	ASPHALT PAVEMENT		L	PAVEMENT
									SAND; fine to medium grained; brown, pale brown; trace silt; trace gravel.	M		MARINE DEPOSITS / AEOLIAN DEPOSITS
					0.5-0.6/S/1 D 0.50 m						L - MD	
			1		1.0-1.1/S/1 D 1.00 m							
				1.20 4.12								
					1.3-1.4/S/1 D 1.30 m				becoming brown at 1.2 m.			
					1.5-1.6/S/1 D 1.50 m							
			2		2.0-2.1/S/ D 2.00 m					D		
					2.5-2.6/S/1 D 2.50 m						VL and L	
			3									
			4		4.0-4.1/S/1 D 4.00 m					M		
AD/V	L	22/05/21									MD	
			5		5.5-5.6/S/1 D 5.50 m							
			6									
				6.55 -1.23					Inferred dense to very dense.			
			7		7.0-7.1/S/1 D 7.00 m					W	D and VD	
			8									
			9									
			10	10.00					Hole Terminated at 10.00 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

MARTENS & ASSOCIATES PTY LTD
Suite 201, 20 George St. Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - BOREHOLE

CLIENT	NSW Department of Education c/- SINSW		COMMENCED	22/05/2021	COMPLETED	22/05/2021	**REF BH102**
PROJECT	Geotechnical Assessment		LOGGED	AG	CHECKED	KB	Sheet 1 OF 1
SITE	Cronulla High School		GEOLOGY	Quaternary Deposits	VEGETATION	None	PROJECT NO. 2108205
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	151.1574	RL SURFACE	5.4 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 10.00 m depth	LATITUDE	-34.03946	ASPECT	North	SLOPE < 5 %

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	H			5.30	0.1-0.2/S/1 D 0.10 m			SP	CONCRETE PAVEMENT			PAVEMENT
	M			*0.40*					Gravelly SAND; fine to medium grained; grey, dark grey; inferred moderately compacted.			FILL
				5.00	0.5-0.6/S/1 D 0.50 m			SP	SAND; fine to medium grained; pale grey, pale brown			MARINE DEPOSITS / AEOLIAN DEPOSITS
			1		1.0-1.1/S/1 D 1.00 m					D	D	
				1.40								
				4.00	1.4-1.5/S/1 D 1.40 m				becoming brown, pale brown at 1.4 m.			
					1.5-1.6/S/1 D 1.50 m						MD	
			2		2.0-2.1/S/ D 2.00 m							
					2.3-2.4/S/1 D 2.30 m							
					2.5-2.6/S/1 D 2.50 m						L	
			3							M	MD	
					4.0-4.1/S/2 D 4.00 m						D	
AD/V	L	22/05/21									MD - D	
			5		5.5-5.6/S/2 D 5.50 m						D	
			6									
			7									
			8							W	VD	
			9									
			10	*10.00*					Hole Terminated at 10.00 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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MARTENS & ASSOCIATES PTY LTD
Suite 201, 20 George St. Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - BOREHOLE

CLIENT	NSW Department of Education c/- SINSW	COMMENCED	22/05/2021	COMPLETED	22/05/2021	**REF BH103**
PROJECT	Geotechnical Assessment	LOGGED	AG	CHECKED	KB	Sheet 1 OF 1
SITE	Cronulla High School	GEOLOGY	Quaternary Deposits	VEGETATION	None	PROJECT NO. 2108205
EQUIPMENT	4WD truck-mounted hydraulic drill rig	LONGITUDE	151.15748	RL SURFACE	5.12 m	DATUM AHD
EXCAVATION DIMENSIONS	Ø100 mm x 10.00 m depth	LATITUDE	-34.03918	ASPECT	West	SLOPE < 5 %

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	L	22/05/21	0	5.12	0.1-0.2/S/1 D 0.10 m			SM	FILL: Silty SAND; fine to medium grained; dark grey, dark brown; trace gravels; poorly to moderately compacted.			FILL
					0.5-0.6/S/1 D 0.50 m							
			1		1.0-1.1/S/1 D 1.00 m							
				1.20 3.92				SP	SAND; fine to medium grained; pale grey, grey, brown.		L	MARINE DEPOSITS / AEOLIAN DEPOSITS
					1.5-1.6/S/1 D 1.50 m							
			2	*1.90* 3.22	2.0-2.1/S/ D 2.00 m				becoming predominantly brown, pale brown at 1.9 m.		L - MD	
					2.4-2.5/S/1 D 2.40 m 2.5-2.6/S/1 D 2.50 m					M		
			3								MD	
			4		4.0-4.1/S/2 D 4.00 m						D	
			5	*5.30* -0.18					Inferred dense to very dense.			
					5.5-5.6/S/2 D 5.50 m							
			6									
					6.5-6.6/S/1 D 6.50 m							
			7							W		
											VD	
			8		8.1-8.2/S/1 D 8.00 m							
			9									
			10	*10.00*					Hole Terminated at 10.00 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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MARTENS & ASSOCIATES PTY LTD
Suite 201, 20 George St. Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - BOREHOLE

CLIENT	NSW Department of Education c/- SINSW		COMMENCED	22/05/2021	COMPLETED	22/05/2021	**REF BH104**
PROJECT	Geotechnical Assessment		LOGGED	AG	CHECKED	KB	Sheet 1 OF 1
SITE	Cronulla High School		GEOLOGY	Quaternary Deposits	VEGETATION	None	PROJECT NO. 2108205
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	151.15745	RL SURFACE	5.43 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 7.00 m depth	LATITUDE	-34.0392	ASPECT	Northwest	SLOPE < 5 %

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	L	22/05/21	0	5.43	0.1-0.2/S/2 D 0.10 m			SM	FILL: Silty SAND; fine to medium grained; dark grey, black, grey; trace brick and gravel pieces; poorly to moderately compacted.			FILL
			1		1.0-1.1/S/2 D 1.00 m							
				1.20								
				4.23				SP	SAND; medium grained; brown, pale brown.			MARINE DEPOSITS / AEOLIAN DEPOSITS
					1.5-1.6/S/2 D 1.50 m						L	
			2		2.0-2.1/S/2 D 2.00 m					M	L - MD	
					2.5-2.6/S/2 D 2.50 m							
			3									
					3.5-3.7/S/2 D 3.50 m						VL - L	
			4		4.0-4.1/S/2 D 4.00 m							
			5								MD	
				5.50								
				-0.07	5.5-5.6/S/2 D 5.50 m				Inferred dense to very dense.	W	D and VD	
			6									
			7	7.00					Hole Terminated at 7.00 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - BOREHOLE

CLIENT	NSW Department of Education c/- SINSW	COMMENCED	23/05/2021	COMPLETED	23/05/2021	**REF BH105**
PROJECT	Geotechnical Assessment	LOGGED	AG	CHECKED	KB	Sheet 1 OF 1
SITE	Cronulla High School	GEOLOGY	Quaternary Deposits	VEGETATION	None	PROJECT NO. 2108205
EQUIPMENT	4WD truck-mounted hydraulic drill rig	LONGITUDE	151.1573	RL SURFACE	5.2 m	DATUM AHD
EXCAVATION DIMENSIONS	Ø100 mm x 7.00 m depth	LATITUDE	-34.03931	ASPECT	Southwest	SLOPE < 5 %

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	L	23/05/21	0	5.20	0.1-0.2/S/2 D 0.10 m			SP	FILL; SAND; fine to medium grained; dark grey, black; trace gravel; trace silt; inferred poorly to moderately compacted.			FILL
					0.5-0.6/S/2 D 0.50 m							
			1		1.0-1.1/S/2 D 1.00 m							
				1.30								
				3.90				SP	SAND; fine to medium grained; pale grey.			MARINE DEPOSITS / AEOLIAN DEPOSITS
					1.5-1.6/S/2 D 1.50 m							
				2.00								
			2	3.20	2.0-2.1/S/2 D 2.00 m				Becoming brown at 2.0 m.	M	L - MD	
					2.5-2.6/S/2 D 2.50 m							
			3								MD	
			4		4.0-4.1/S/2 D 4.00 m							
											D	
											L - MD	
			5								MD	
					5.5-5.6/S/2 D 5.50 m					W		
			6	*6.00* -0.80					Becoming grey, pale grey at 6.0 m.		D	
					6.5-6.7/S/1 D 6.50 m							
			7	*7.00*					Hole Terminated at 7.00 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	NSW Department of Education c/- SINSW	COMMENCED	23/05/2021	COMPLETED	23/05/2021	**REF BH106**
PROJECT	Geotechnical Assessment	LOGGED	AG	CHECKED	KB	Sheet 1 OF 1
SITE	Cronulla High School	GEOLOGY	Quaternary Deposits	VEGETATION	None	PROJECT NO. 2108205
EQUIPMENT	4WD truck-mounted hydraulic drill rig	LONGITUDE	151.1584	RL SURFACE	5.29 m	DATUM AHD
EXCAVATION DIMENSIONS	Ø100 mm x 7.00 m depth	LATITUDE	-34.0388	ASPECT	South	SLOPE < 5 %

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				0.10 5.19					CONCRETE PAVEMENT			PAVEMENT
AD/V	L	23/05/21	1		0.1-0.2/S/2 D 0.10 m			SP	SAND; fine to medium grained; dark grey.		L	MARINE DEPOSITS / AEOLIAN DEPOSITS
				0.50 4.79	0.5-0.6/S/2 D 0.50 m				becoming pale grey at 0.5 m		MD - D	
				1.00 4.29	1.0-1.1/S/2 D 1.00 m				becoming brown, dark brown at 1.0 m	M		
			2		1.5-1.6/S/2 D 1.50 m						L	
					2.0-2.1/S/2 D 2.00 m							
				2.40 2.89	2.5-2.6/S/2 D 2.50 m				becoming brown, pale brown at 2.4 m		MD	
			3								D	
											MD	
			4		4.0-4.1/S/2 D 4.00 m							
				4.50 0.79					Inferred dense to very dense.	W		
			5									
					5.5-5.6/S/2 D 5.50 m						D and VD	
			6									
			7	7.00					Hole Terminated at 7.00 m (Target depth reached)			

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	NSW Department of Education c/- SINSW	COMMENCED	23/05/2021	COMPLETED	23/05/2021	**REF BH107**
PROJECT	Geotechnical Assessment	LOGGED	AG	CHECKED	KB	Sheet 1 OF 1
SITE	Cronulla High School	GEOLOGY	Quaternary Deposits	VEGETATION	None	PROJECT NO. 2108205
EQUIPMENT	4WD truck-mounted hydraulic drill rig	LONGITUDE	151.15818	RL SURFACE	5.29 m	DATUM AHD
EXCAVATION DIMENSIONS	Ø100 mm x 7.00 m depth	LATITUDE	-34.03905	ASPECT	North	SLOPE < 5 %

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	H			*0.10*					CONCRETE PAVEMENT			PAVEMENT
				5.19	0.1-0.2/S/2 D 0.10 m			SP	SAND; fine to medium grained; pale grey.		L	MARINE DEPOSITS / AEOLIAN DEPOSITS
					0.5-0.6/S/2 D 0.50 m						D	
			1	*1.10*	1.0-1.1/S/2 D 1.00 m							
				4.19					becoming pale brown at 1.1 m.			
				1.40								
				3.89					becoming brown, dark brown at 1.4 m.			
					1.5-1.6/S/2 D 1.50 m					M	L - MD	
			2		2.0-2.1/S/2 D 2.00 m							
					2.5-2.6/S/2 D 2.50 m							
AD/V	L	23/05/21	3								MD	
					4.0-4.1/S/2 D 4.00 m							
			4		4.7-4.9/S/2 D 4.70 m							
			5	*5.15*								
				0.14					Inferred dense.	W	D	
					5.5-5.6/S/2 D 5.50 m							
			6									
			7	*7.00*					Hole Terminated at 7.00 m (Target depth reached)			

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Engineering Log - BOREHOLE

CLIENT	NSW Department of Education c/- SINSW		COMMENCED	23/05/2021	COMPLETED	23/05/2021	**REF BH108**
PROJECT	Geotechnical Assessment		LOGGED	AG	CHECKED	KB	Sheet 1 OF 1
SITE	Cronulla High School		GEOLOGY	Quaternary Deposits	VEGETATION	Grass	PROJECT NO. 2108205
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	151.1573	RL SURFACE	2.41 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 4.20 m depth	LATITUDE	-34.0392	ASPECT	Southwest	SLOPE < 5 %

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				2.41								
HA	M				0.1-0.2/S/2 D 0.10 m			SM	Silty SAND; fine to medium grained; dark grey.		L	TOPSOIL
				0.30								
				2.11				SP	SAND; fine to medium grained; grey, pale grey; trace silt.			MARINE DEPOSITS / AEOLIAN DEPOSITS
					0.5-0.6/S/2 D 0.50 m					M		
			1		1.0-1.1/S/2 D 1.00 m						MD	
		23/05/21										
					1.5-1.6/S/2 D 1.50 m							
				1.80								
				0.61					becoming dark brown, dark grey with silt at 1.8 m.			
AD/V	L		2		2.0-2.1/S/2 D 2.00 m						D	
					2.5-2.6/S/2 D 2.50 m					W		
			3	*3.05*								
				-0.64					Inferred dense to very dense.			
											VD	
			4		4.0-4.1/S/2 D 4.00 m							
				4.20								
									Hole Terminated at 4.20 m (Target depth reached)			
			5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	NSW Department of Education c/- SINSW		COMMENCED	23/05/2021	COMPLETED	23/05/2021	**REF BH109**
PROJECT	Geotechnical Assessment		LOGGED	AG	CHECKED	KB	Sheet 1 OF 1
SITE	Cronulla High School		GEOLOGY	Quaternary Deposits	VEGETATION	Grass	PROJECT NO. 2108205
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	151.1571	RL SURFACE	2.83 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 2.60 m depth	LATITUDE	-34.03943	ASPECT	North	SLOPE < 5 %

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				2.83				SM	FILL; Silty SAND; fine to medium grained; dark grey, brown; trace roots, trace iron nails, trace concrete boulders; trace gravel; inferred moderately compacted.			FILL
HA	M				0.1-0.2/S/2 D 0.10 m 0.2-0.7/CBR/1 D 0.20 m							
			0.5		0.5-0.6/S/2 D 0.50 m					M		
			1.0		1.0-1.1/S/2 D 1.00 m							
				1.10								
				1.73				SP	SAND; fine to medium grained; brown; pale brown.			MARINE DEPOSITS / AEOLIAN DEPOSITS
AD/V	L	23/05/21	1.5		1.5-1.6/S/2 D 1.50 m						MD	
			2.0		2.0-2.1/S/2 D 2.00 m					W	L	
			2.5		2.5-2.6/S/2 D 2.50 m							
				2.60					Hole Terminated at 2.60 m (Target depth reached)			
			3.0									
			3.5									
			4.0									
			4.5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	NSW Department of Education c/- SINSW		COMMENCED	23/05/2021	COMPLETED	23/05/2021	**REF BH110**
PROJECT	Geotechnical Assessment		LOGGED	AG	CHECKED	KB	Sheet 1 OF 1
SITE	Cronulla High School		GEOLOGY	Quaternary Deposits	VEGETATION	Grass	PROJECT NO. 2108205
EQUIPMENT		4WD truck-mounted hydraulic drill rig	LONGITUDE	151.15702	RL SURFACE	5.2 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 4.20 m depth	LATITUDE	-34.03955	ASPECT	West	SLOPE < 5 %

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	L	Not Encountered	1	5.20	0.1-0.2/S/2 D 0.10 m				FILL; SAND; fine to medium grained; dark grey, dark brown; trace metal wire; trace gravel; trace glass pieces; with roots; inferred poorly to moderately compacted.	M		FILL
					0.5-0.6/S/2 D 0.50 m							
					1.0-1.1/S/2 D 1.00 m 1.0-1.5/CBR/1 D 1.00 m							
					1.5-1.6/S/2 D 1.50 m							
			2		2.0-2.1/S/2 D 2.00 m							
					2.5-2.6/S/2 D 2.50 m							
			3		3.0-3.2/S/2 D 3.00 m							
				3.70								
				1.50				SP	SAND; fine to medium grained; pale brown; inferred loose to medium dense.	W	L - MD	MARINE DEPOSITS / AEOLIAN DEPOSITS
			4		4.0-4.1/S/1 D 4.00 m							
				4.20					Hole Terminated at 4.20 m (Target depth reached)			
			5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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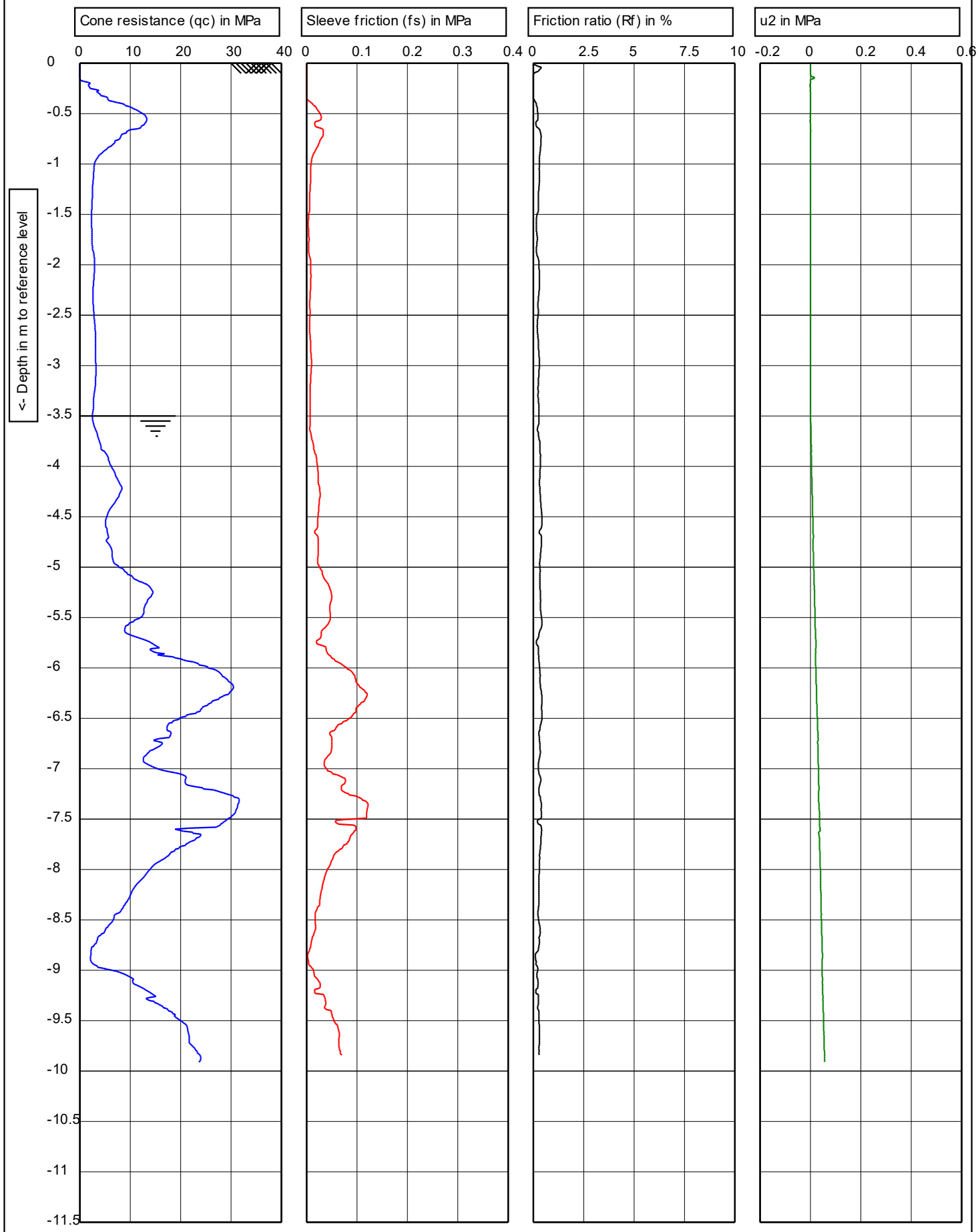
Engineering Log - BOREHOLE

14 Attachment F – CPT Logs



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

r u2
L 150 cm²
10 cm²

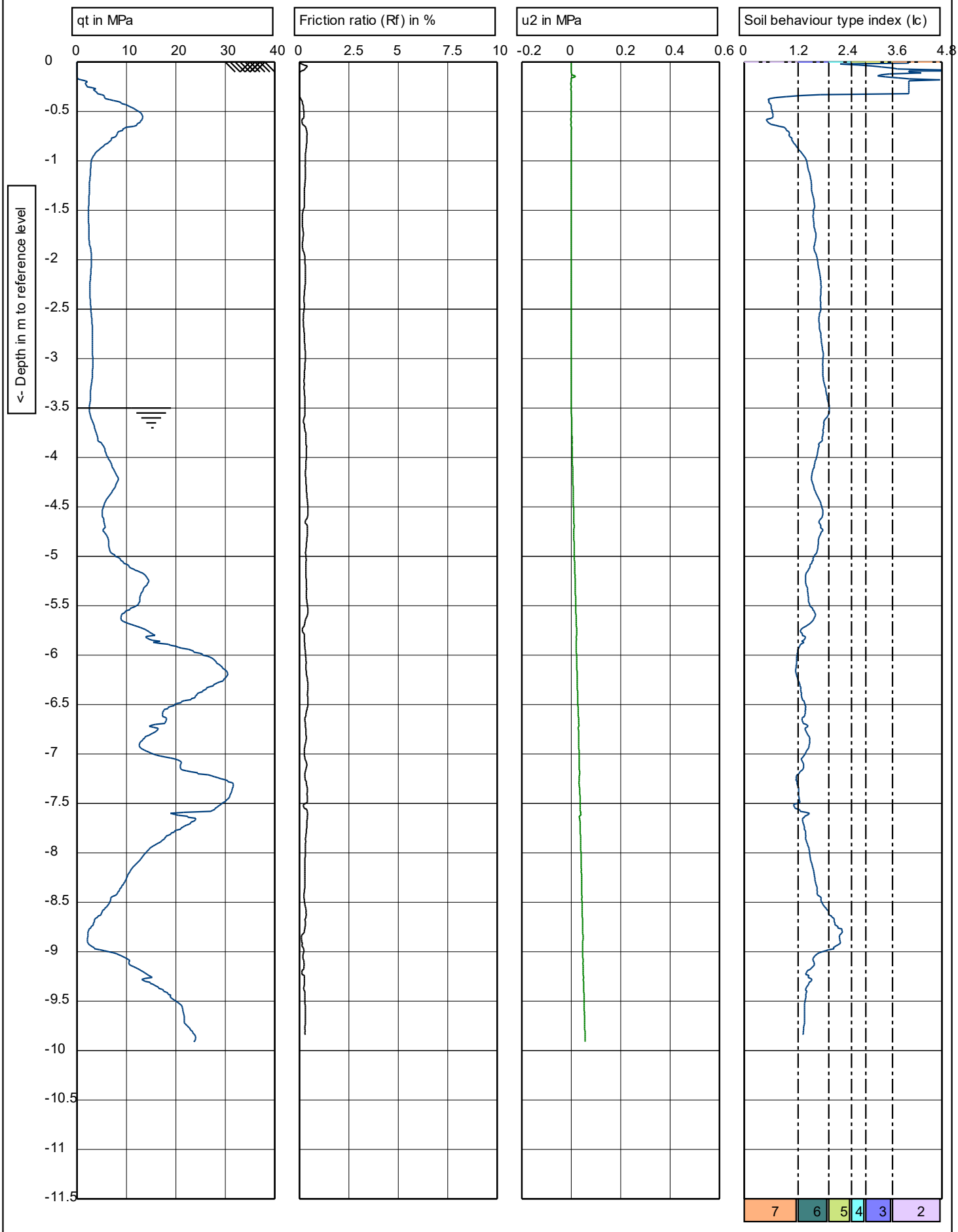
ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.50 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

Predrill:	**0.00 m Predrilled**
Date:	**6/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT-01** **1/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

r u2
L 150 cm²
10 cm²

ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.50 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

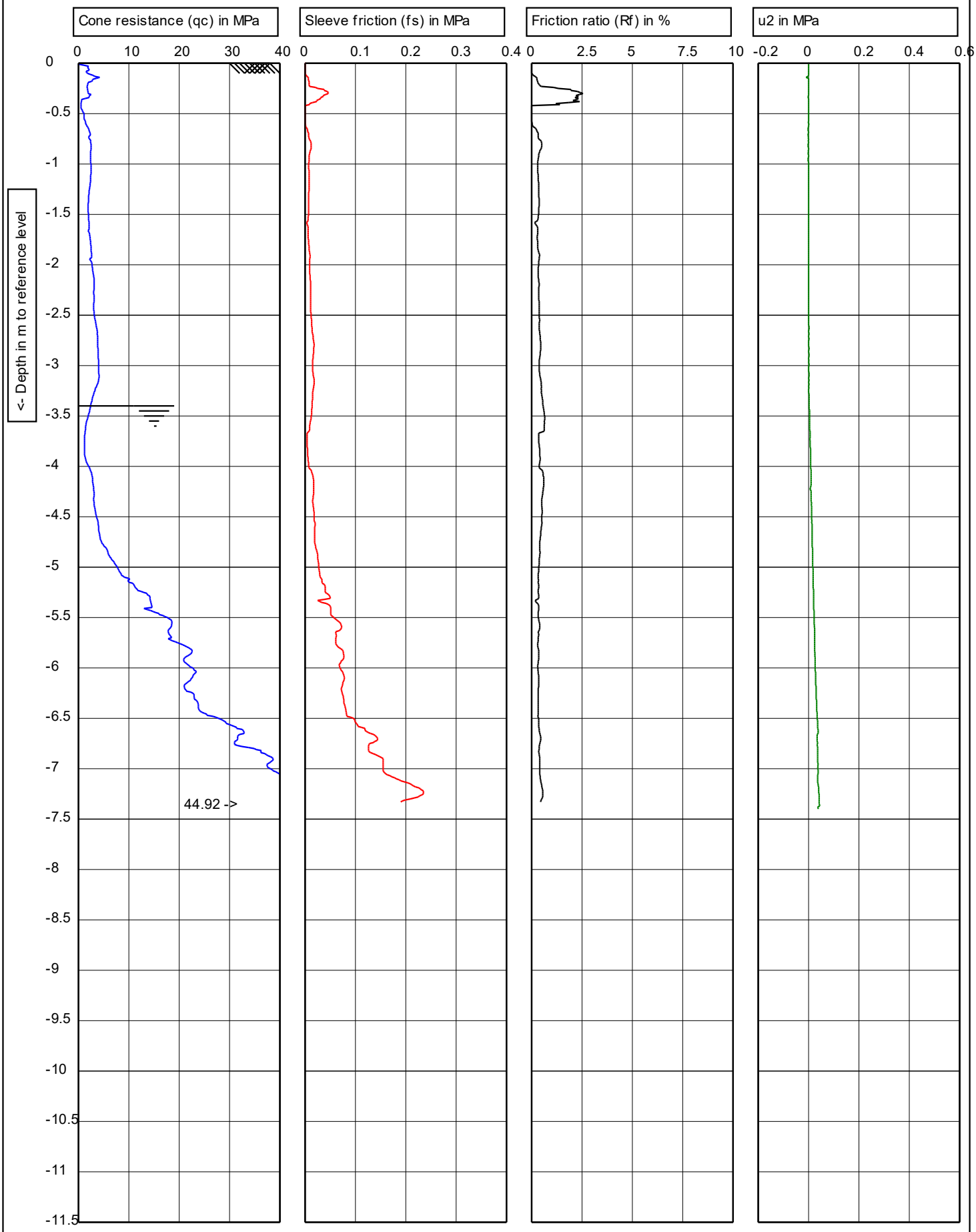
Predrill:	**0.00 m Predrilled**
Date:	**6/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT-01** 2/3

1.44

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD GEOTECHNICAL TESTING **Ph. 0408 292638**	⌜ u2 └ 150 cm² 10 cm²	ISO 22476-1:2012 Application class 1 Testtype TE1		Predrill:	**0.00 m Predrilled**
		G.L.: **0.00 m**	W.L.: **-3.50 m**	Date:	**6/07/2022**
	Project:	**Geotechnical Investigation**		Cone no.:	**C10CFIIP.C18245**
	Location:	**CROUNLLA HIGH SCHOOL**		Project no.:	**8205**
	Position:	**0, 0**		CPT no.:	**CPT-01** **3/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

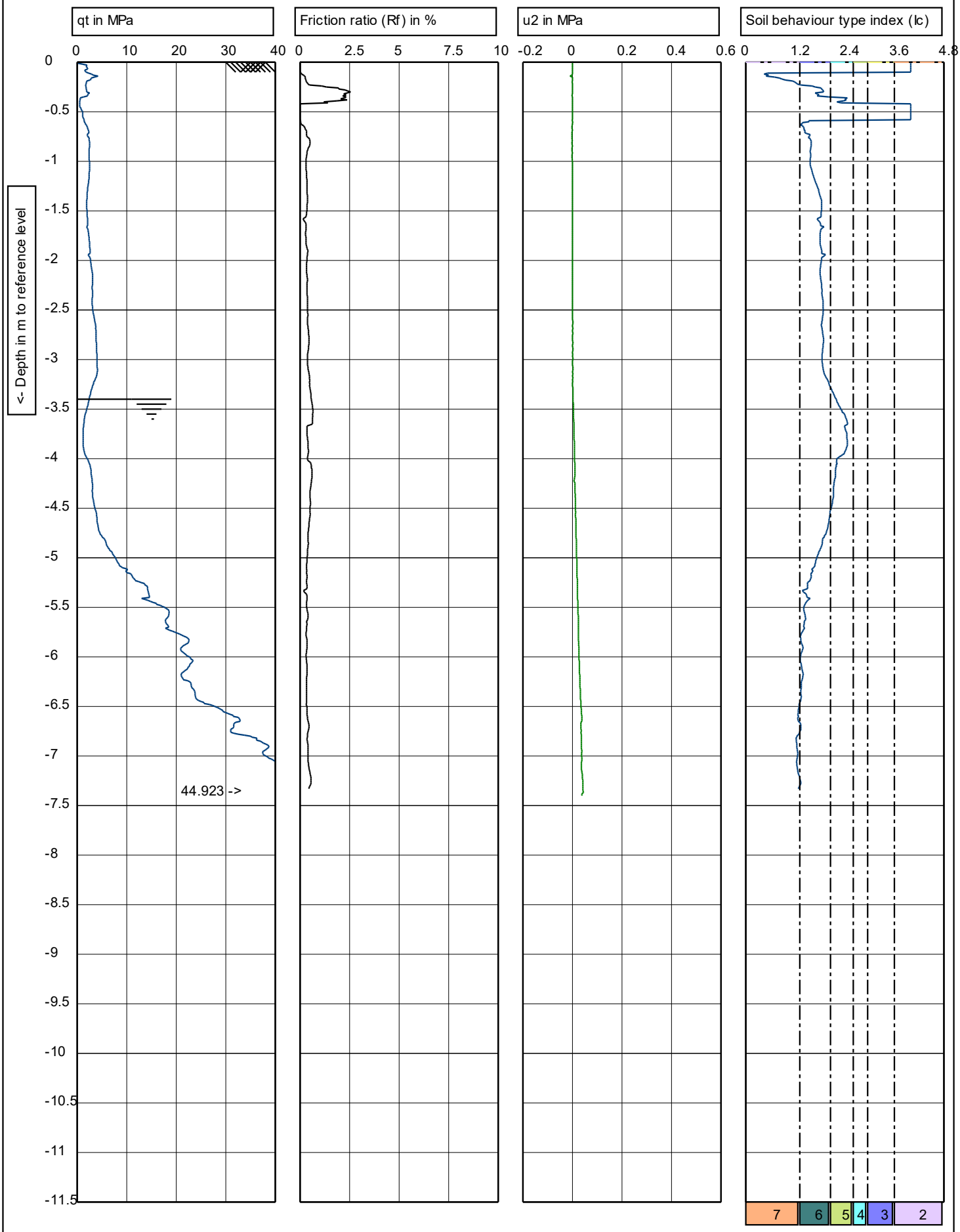
ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

Predrill:	**0.00 m Predrilled**
Date:	**6/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT-02** **1/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

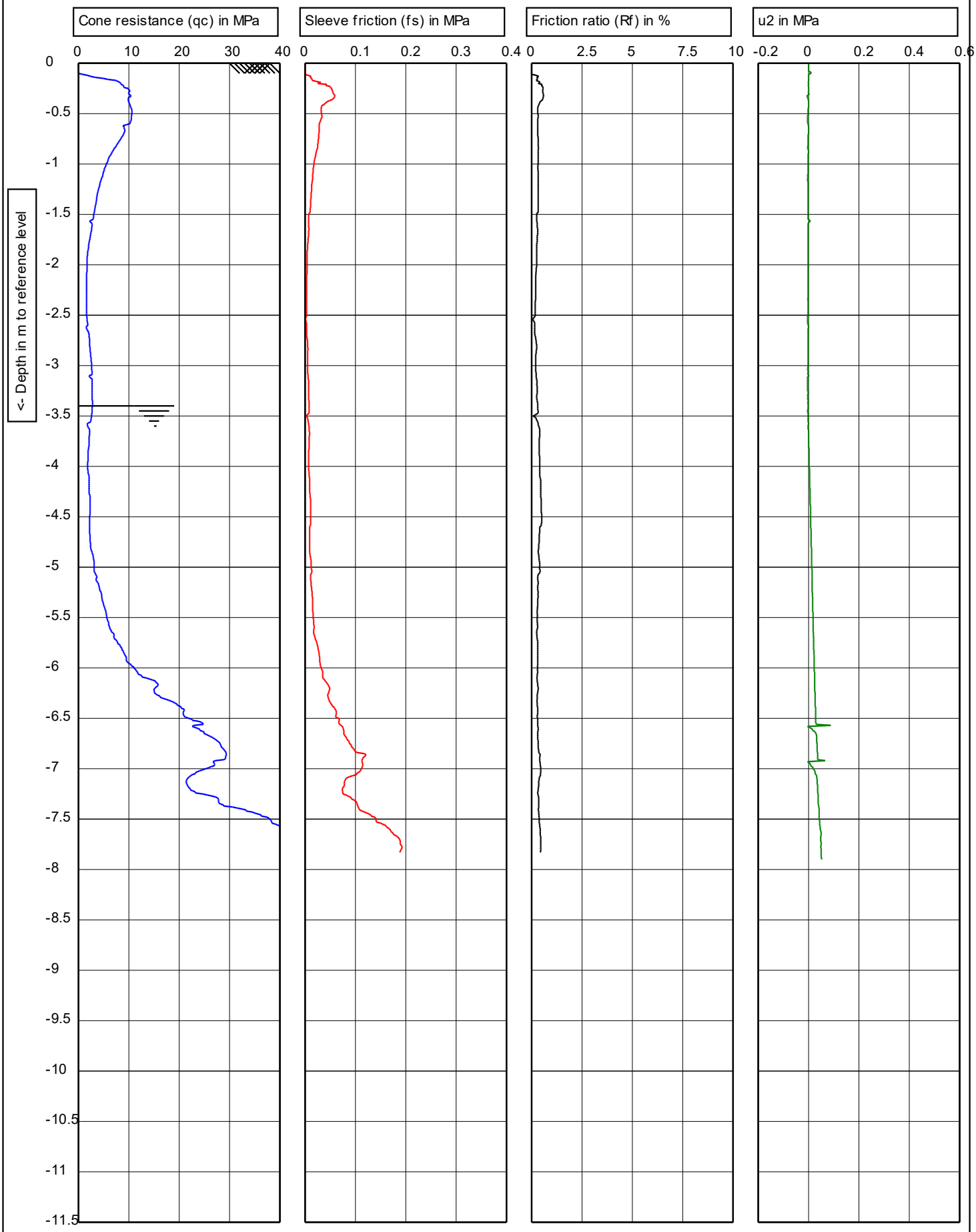
Predrill:	**0.00 m Predrilled**
Date:	**6/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT-02** 2/3

1.44

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD GEOTECHNICAL TESTING **Ph. 0408 292638**	⌜ u2 └ 150 cm² 10 cm²	ISO 22476-1:2012 Application class 1 Testtype TE1		Predrill:	**0.00 m Predrilled**
		G.L.: **0.00 m**	W.L.: **-3.40 m**	Date:	**6/07/2022**
	Project:	**Geotechnical Investigation**		Cone no.:	**C10CFIIP.C18245**
	Location:	**CROUNLLA HIGH SCHOOL**		Project no.:	**8205**
	Position:	**0, 0**		CPT no.:	**CPT-02** **3/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

r u2
L 150 cm²
10 cm²

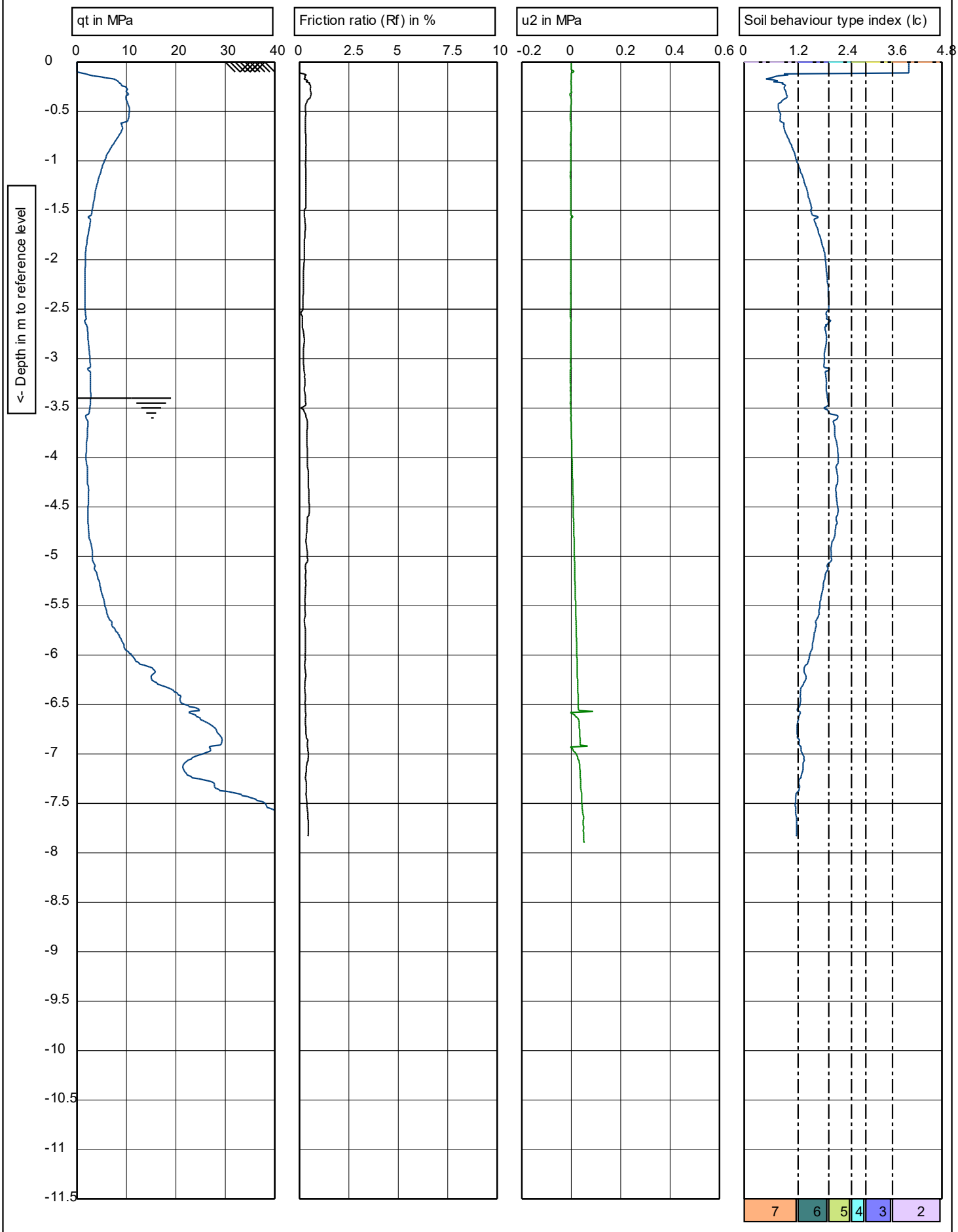
ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

Predrill:	**0.00 m Predrilled**
Date:	**6/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT-03** **1/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

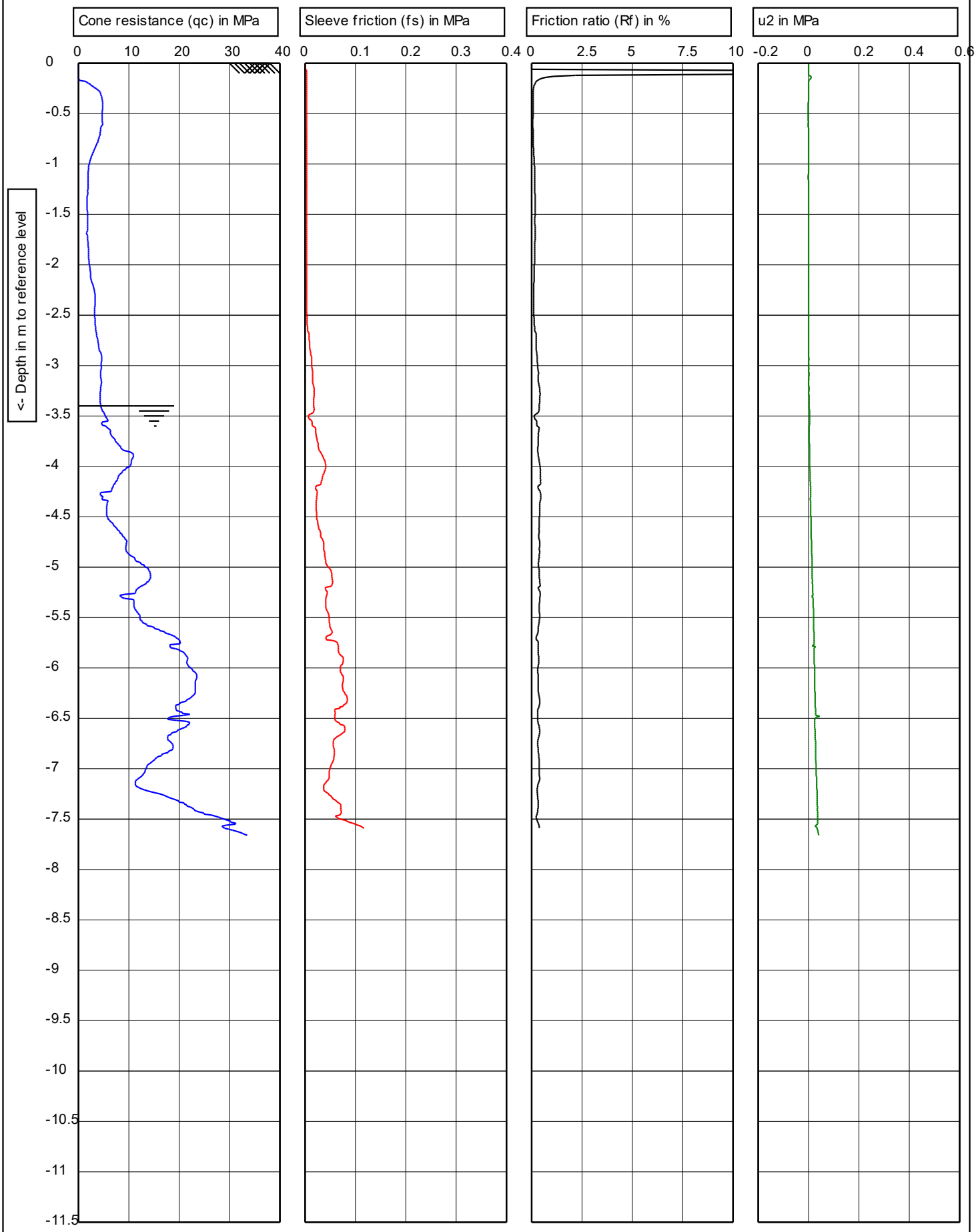
Predrill:	**0.00 m Predrilled**
Date:	**6/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT-03** 2/3

1.44

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD GEOTECHNICAL TESTING **Ph. 0408 292638**	⌜ u2 └ 150 cm² 10 cm²	ISO 22476-1:2012 Application class 1 Testtype TE1		Predrill:	**0.00 m Predrilled**
		G.L.: **0.00 m**	W.L.: **-3.40 m**	Date:	**6/07/2022**
	Project:	**Geotechnical Investigation**		Cone no.:	**C10CFIIP.C18245**
	Location:	**CROUNLLA HIGH SCHOOL**		Project no.:	**8205**
	Position:	**0, 0**		CPT no.:	**CPT-03** **3/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

u2
150 cm²
10 cm²

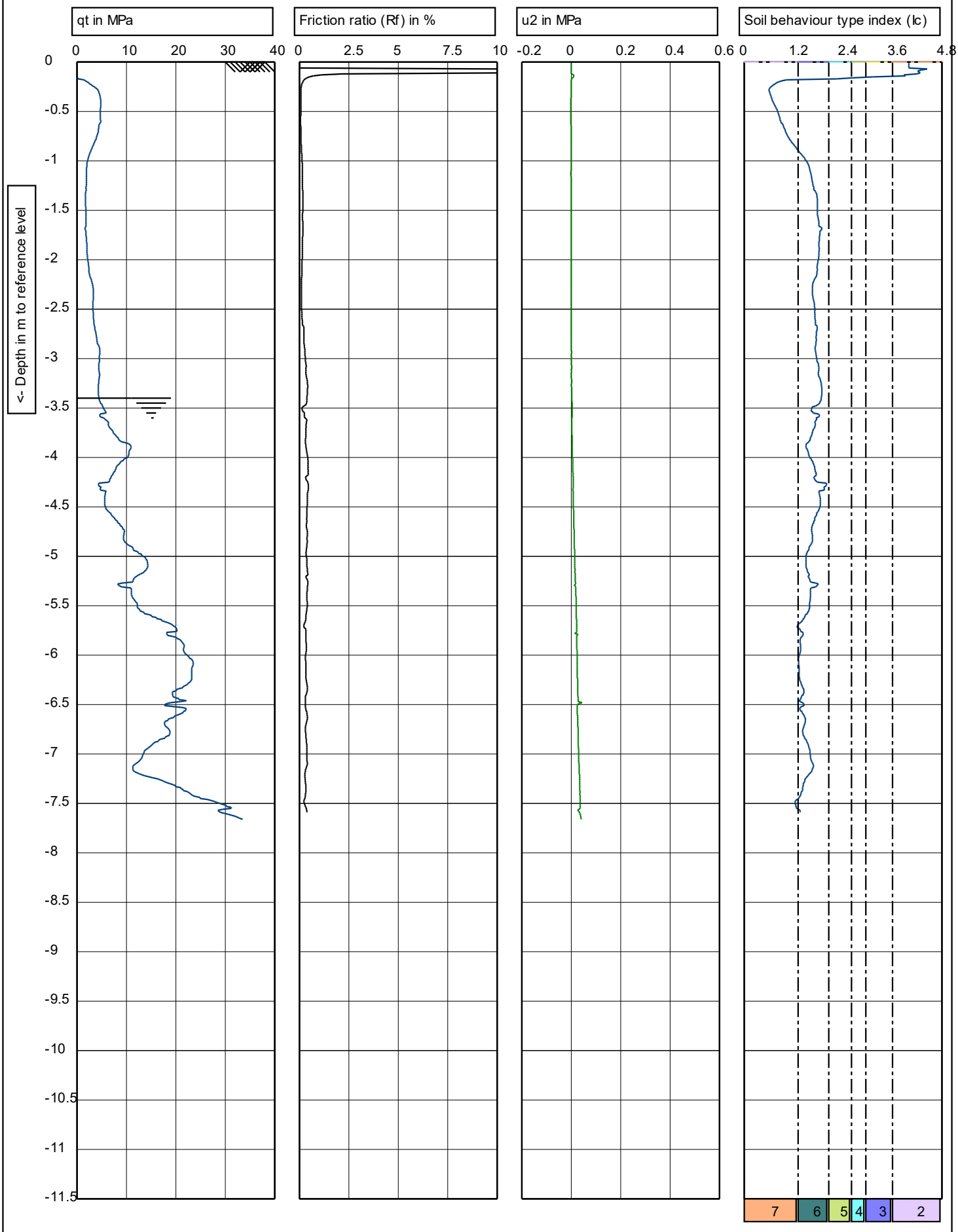
ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

Predrill:	**0.00 m Predrilled**
Date:	**6/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**Testtype TE1**
CPT no.:	**CPT-04**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

r u2
L 150 cm²
10 cm²

ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

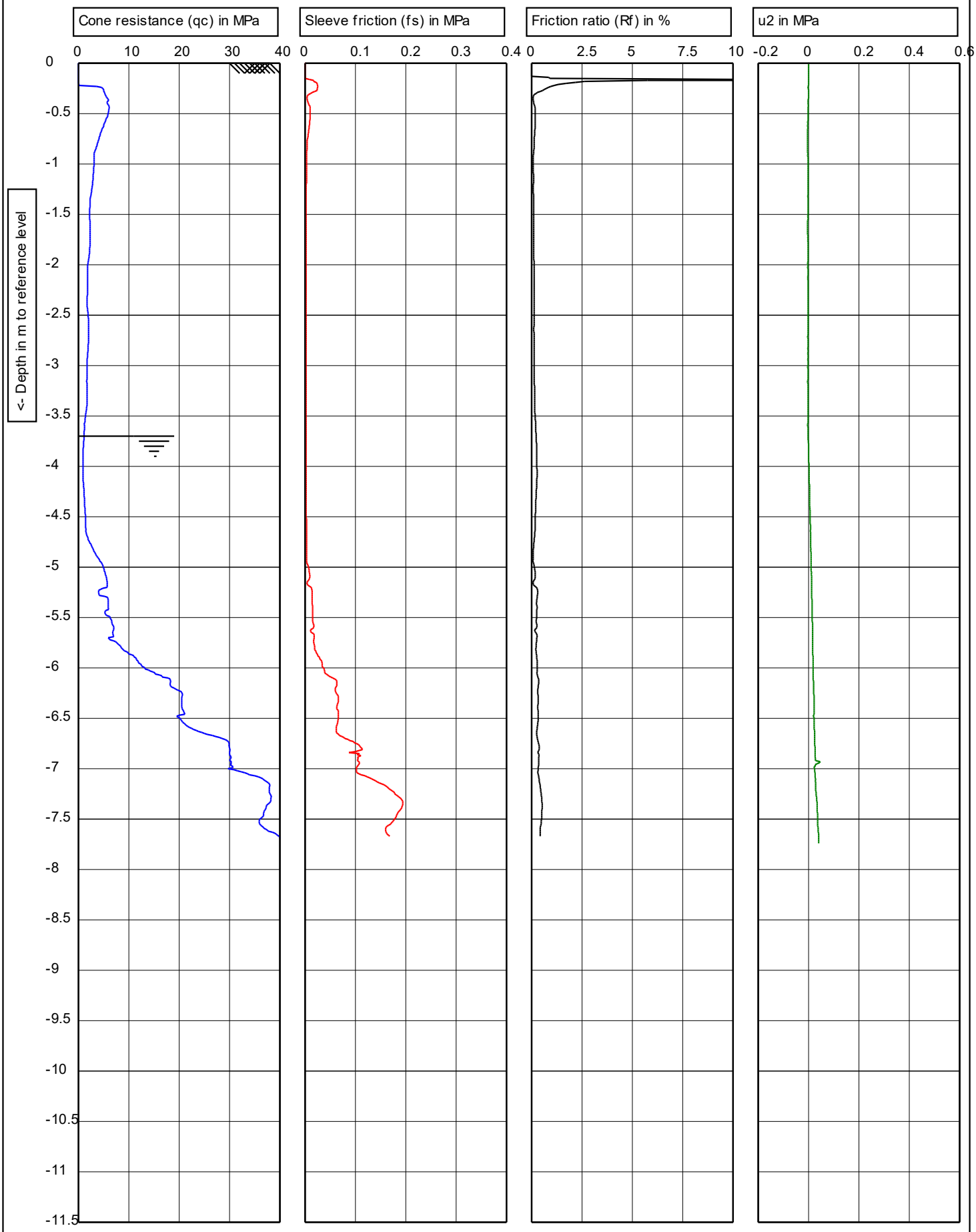
Predrill:	**0.00 m Predrilled**
Date:	**6/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**Testtype TE1**
CPT no.:	**CPT-04** 2/3

1.44

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD GEOTECHNICAL TESTING **Ph. 0408 292638**	⌜ u2 └ 150 cm² 10 cm²	ISO 22476-1:2012 Application class 1 Testtype TE1		Predrill:	**0.00 m Predrilled**
		G.L.: **0.00 m**	W.L.: **-3.40 m**	Date:	**6/07/2022**
	Project:	**Geotechnical Investigation**		Cone no.:	**C10CFIIP.C18245**
	Location:	**CROUNLLA HIGH SCHOOL**		Project no.:	**Testtype TE1**
	Position:	**0, 0**		CPT no.:	**CPT-04** **3/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

u2
150 cm²
10 cm²

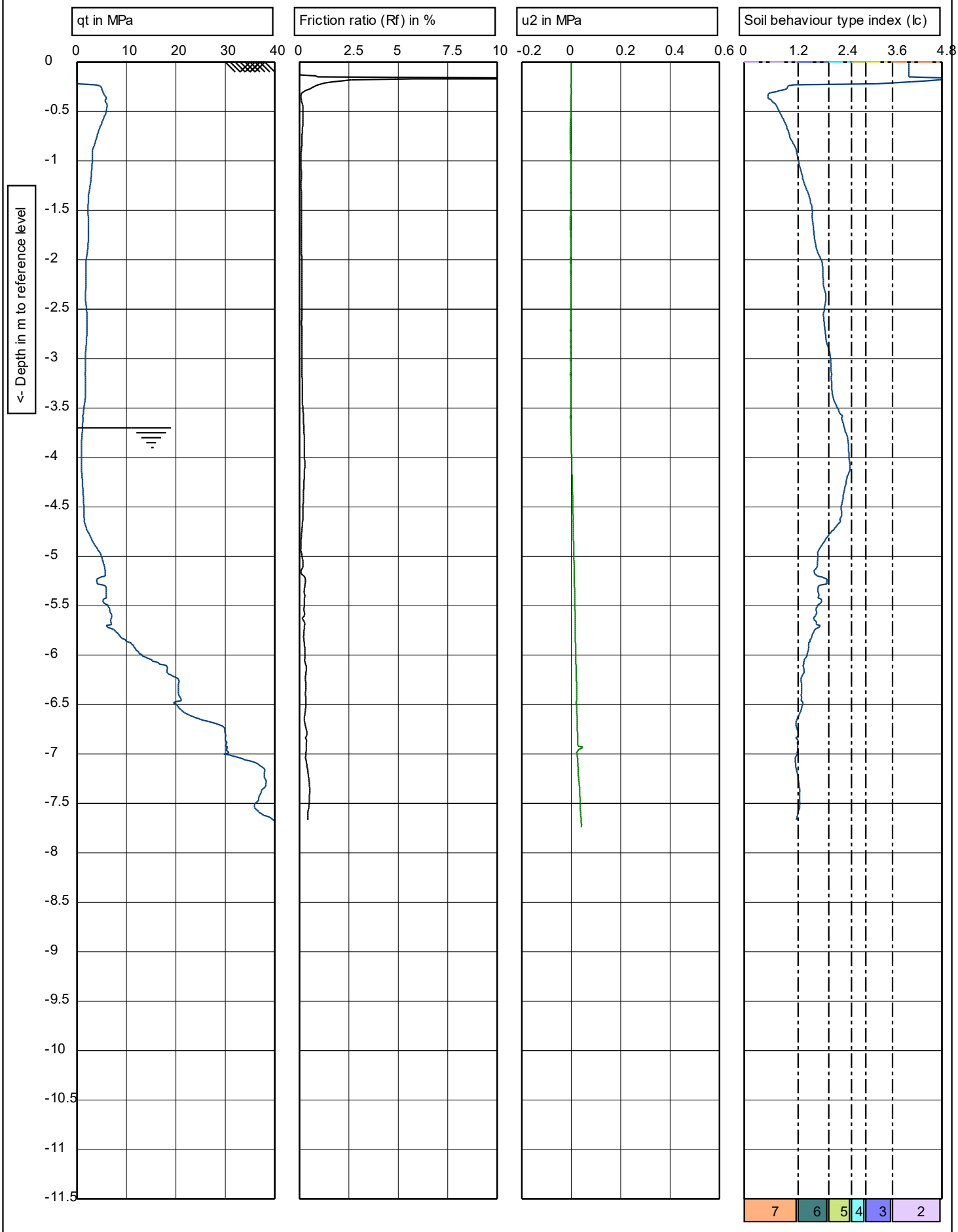
ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.70 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

Predrill:	**0.00 m Predrilled**
Date:	**7/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT - 05** **1/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.70 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

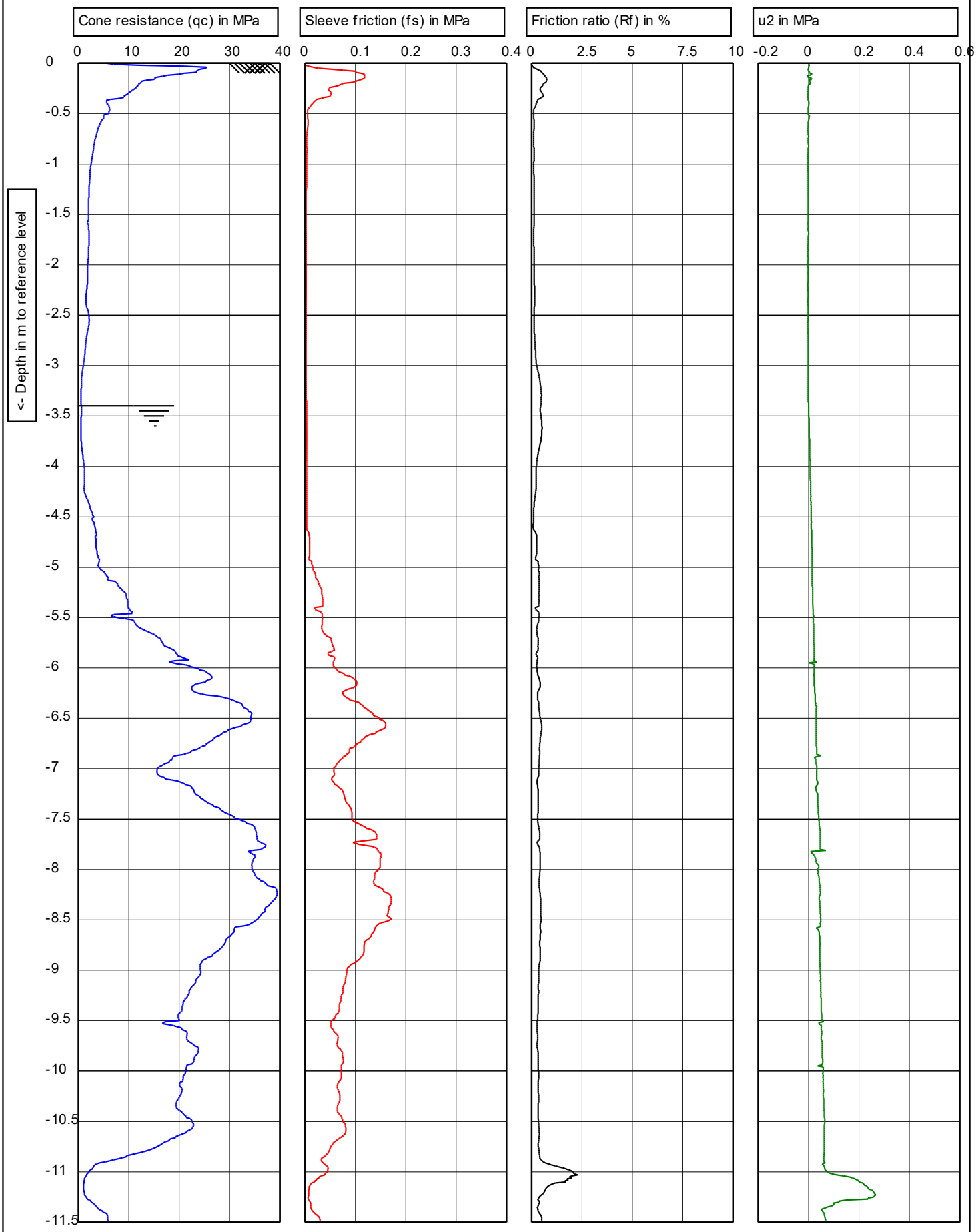
Predrill:	**0.00 m Predrilled**
Date:	**7/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT - 05** 2/3

1.44

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD GEOTECHNICAL TESTING **Ph. 0408 292638**	⌜ u2 └ 150 cm² 10 cm²	ISO 22476-1:2012 Application class 1 Testtype TE1		Predrill:	**0.00 m Predrilled**
		G.L.: **0.00 m**	W.L.: **-3.70 m**	Date:	**7/07/2022**
	Project:	**Geotechnical Investigation**		Cone no.:	**C10CFIIP.C18245**
	Location:	**CROUNLLA HIGH SCHOOL**		Project no.:	**8205**
	Position:	**0, 0**		CPT no.:	**CPT - 05** **3/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

r u2
L 150 cm²
10 cm²

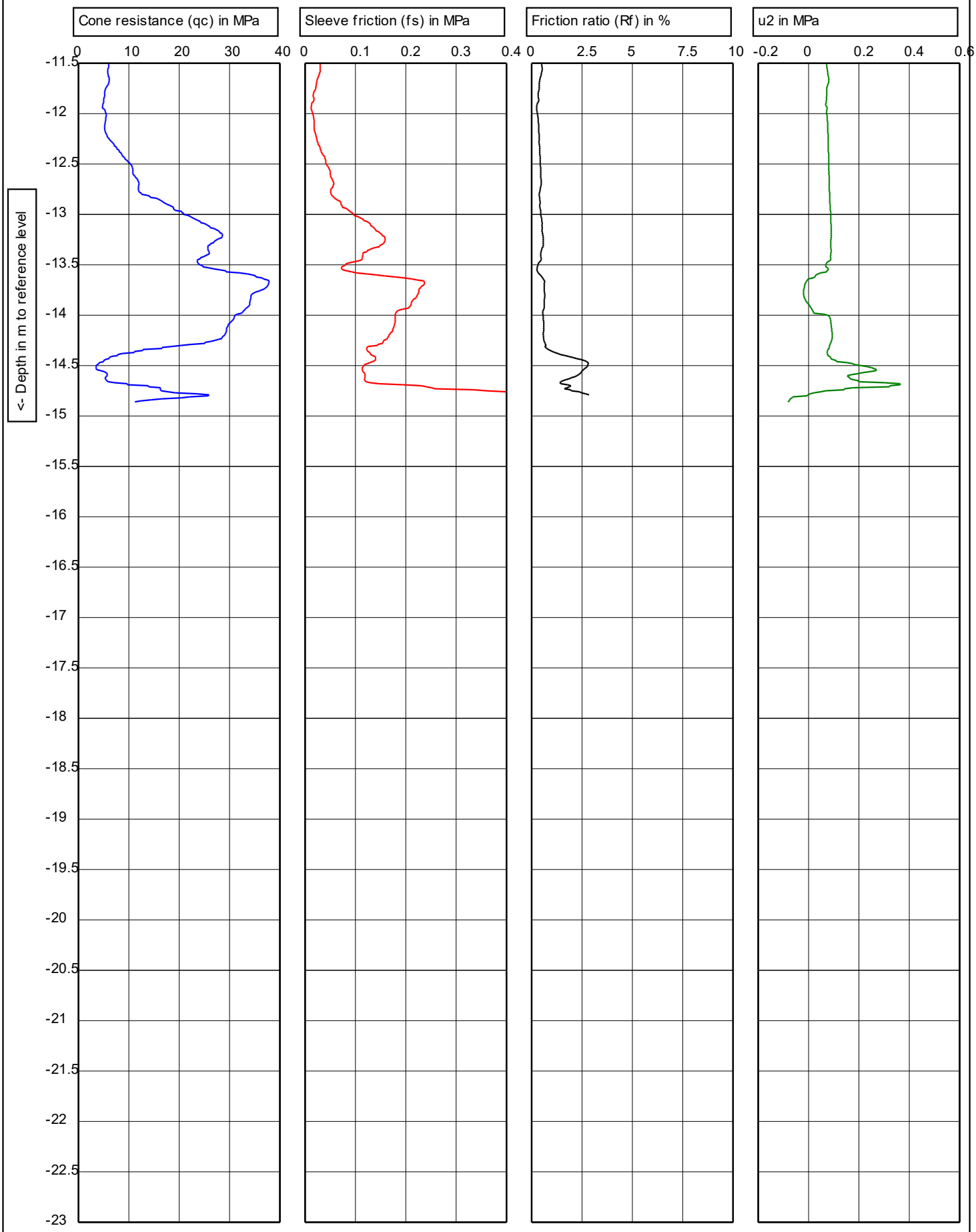
ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

Predrill:	**0.00 m Predrilled**
Date:	**7/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT - 06** **1/6**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

r u2
L 150 cm²
10 cm²

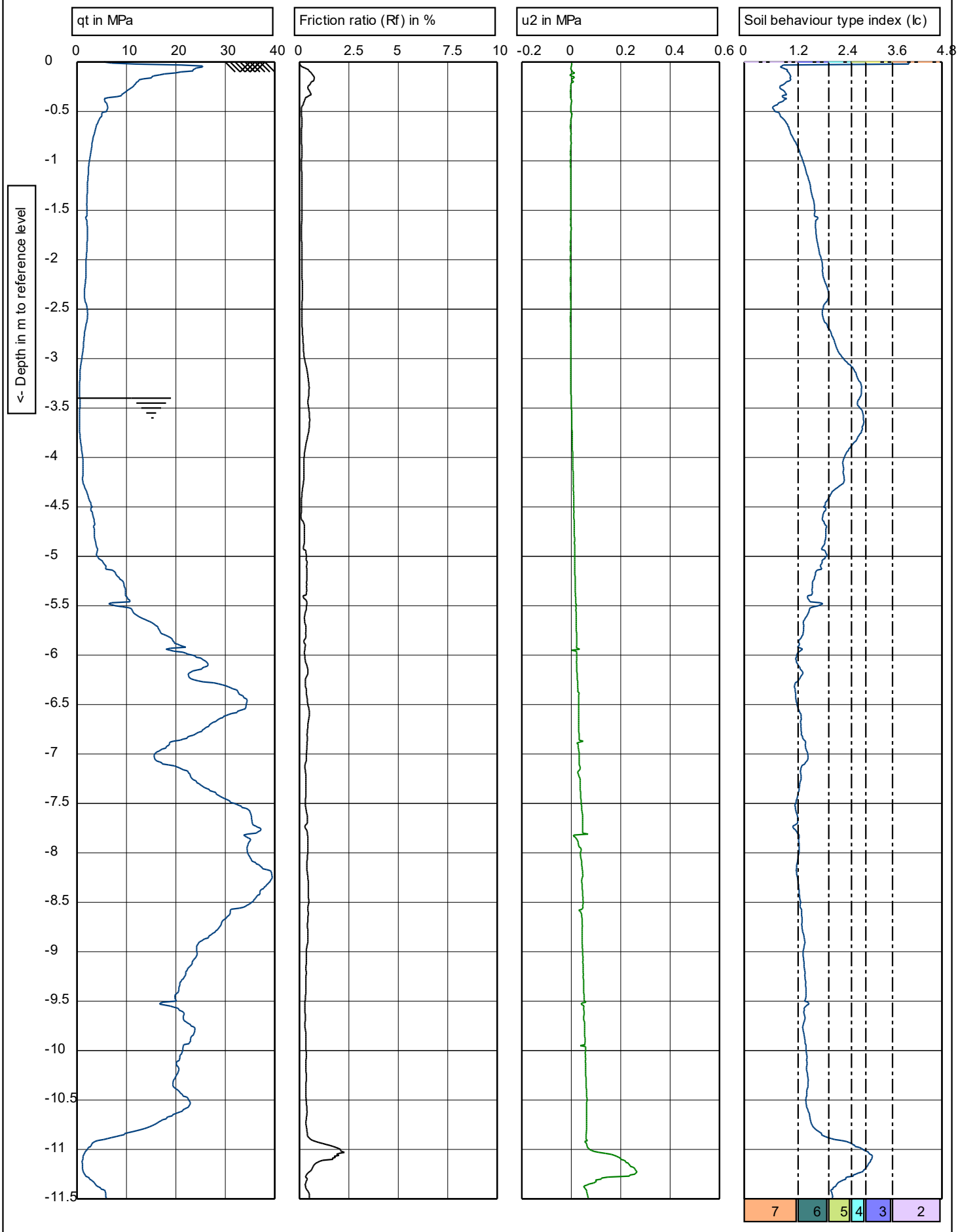
ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

Predrill:	**0.00 m Predrilled**
Date:	**7/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT - 06** **2/6**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

r u2
150 cm²
10 cm²

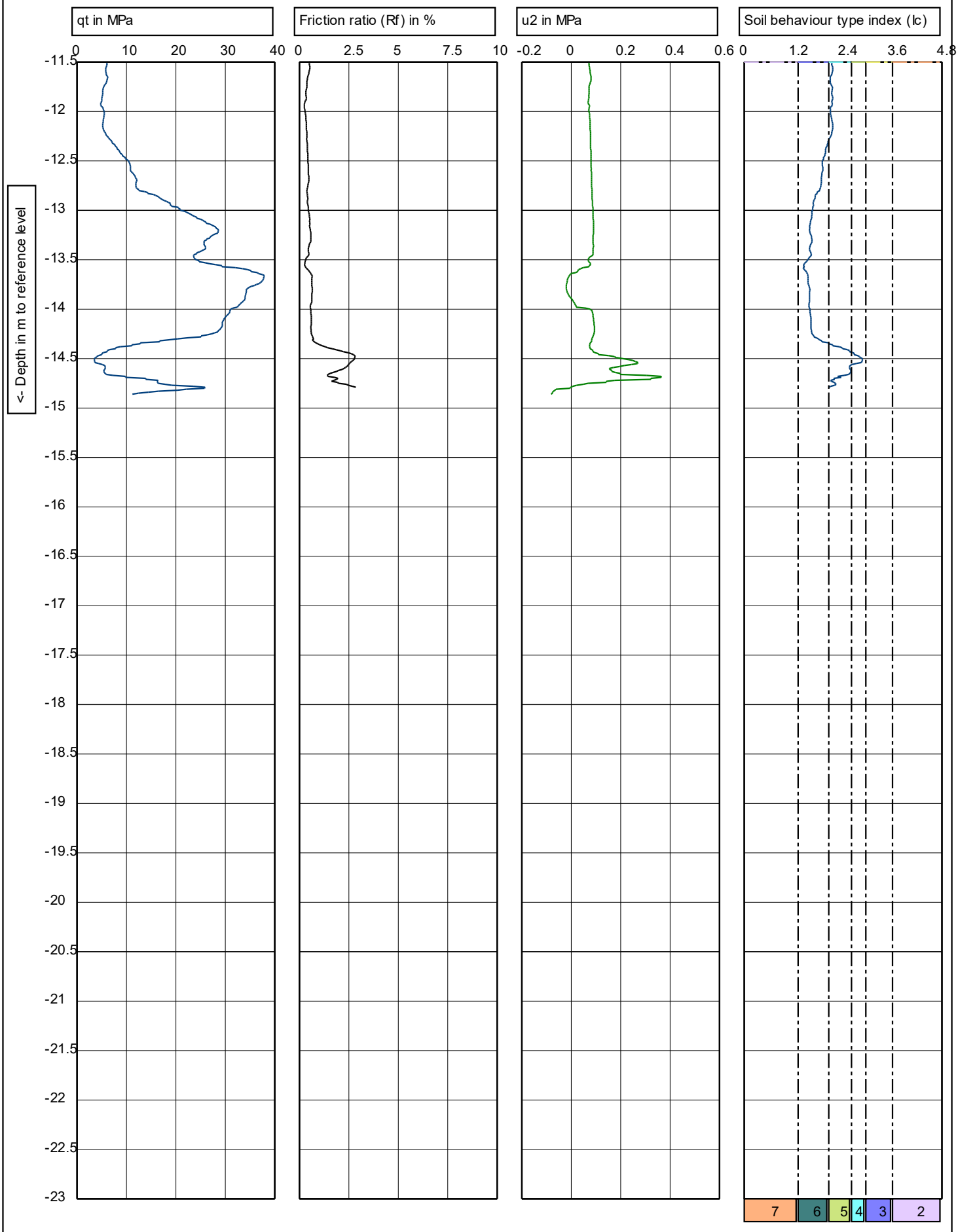
ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

Predrill:	**0.00 m Predrilled**
Date:	**7/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT - 06** 3/6

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

r u2
L 150 cm²
10 cm²

ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

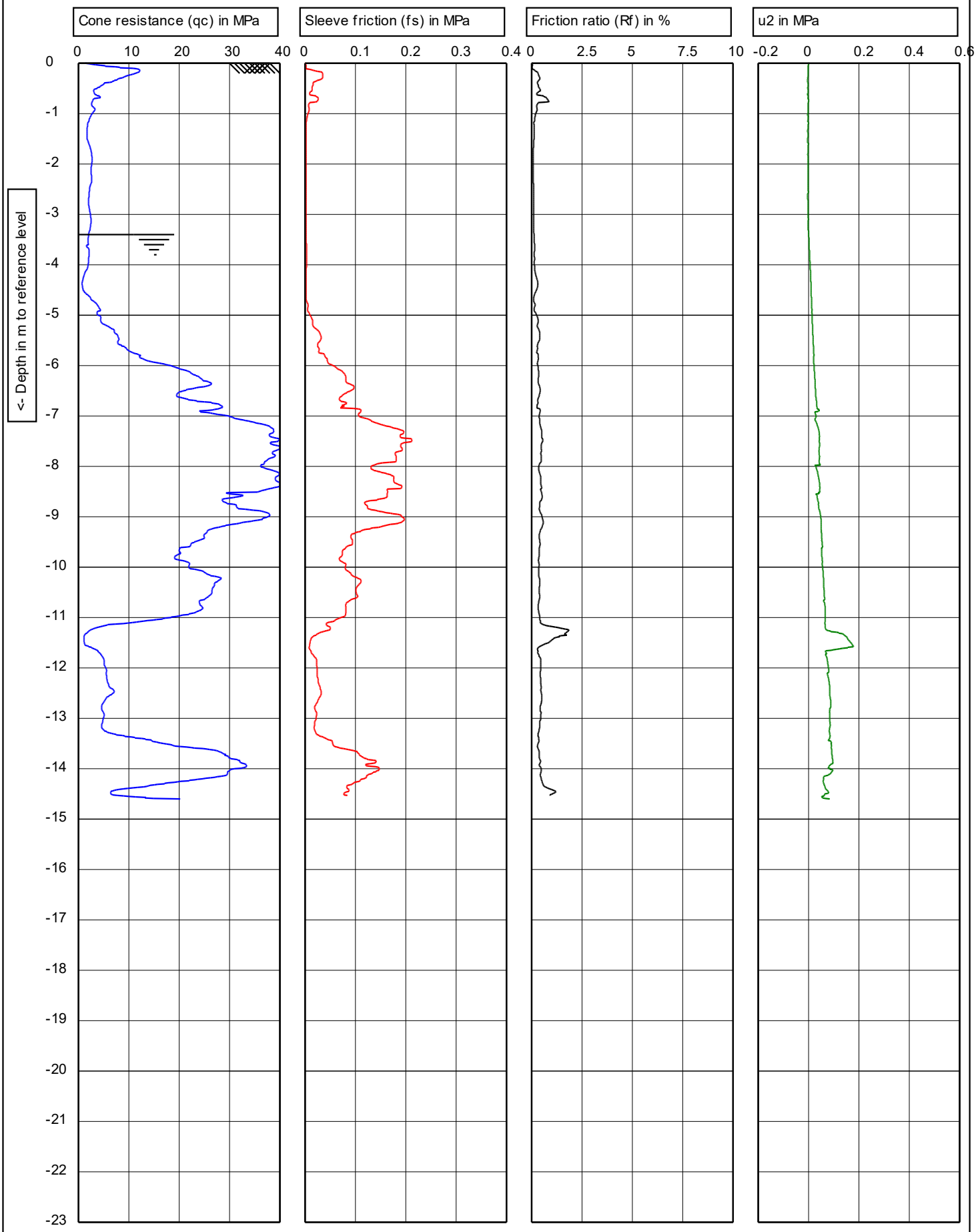
Predrill:	**0.00 m Predrilled**
Date:	**7/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	**8205**
CPT no.:	**CPT - 06** **4/6**

1.44

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD GEOTECHNICAL TESTING **Ph. 0408 292638**	⌜ u2 └ 150 cm² 10 cm²	ISO 22476-1:2012 Application class 1 Testtype TE1		Predrill:	**0.00 m Predrilled**
		G.L.: **0.00 m**	W.L.: **-3.40 m**	Date:	**7/07/2022**
	Project:	**Geotechnical Investigation**		Cone no.:	**C10CFIIP.C18245**
	Location:	**CROUNLLA HIGH SCHOOL**		Project no.:	**8205**
	Position:	**0, 0**		CPT no.:	**CPT - 06** **3/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

u2
150 cm²
10 cm²

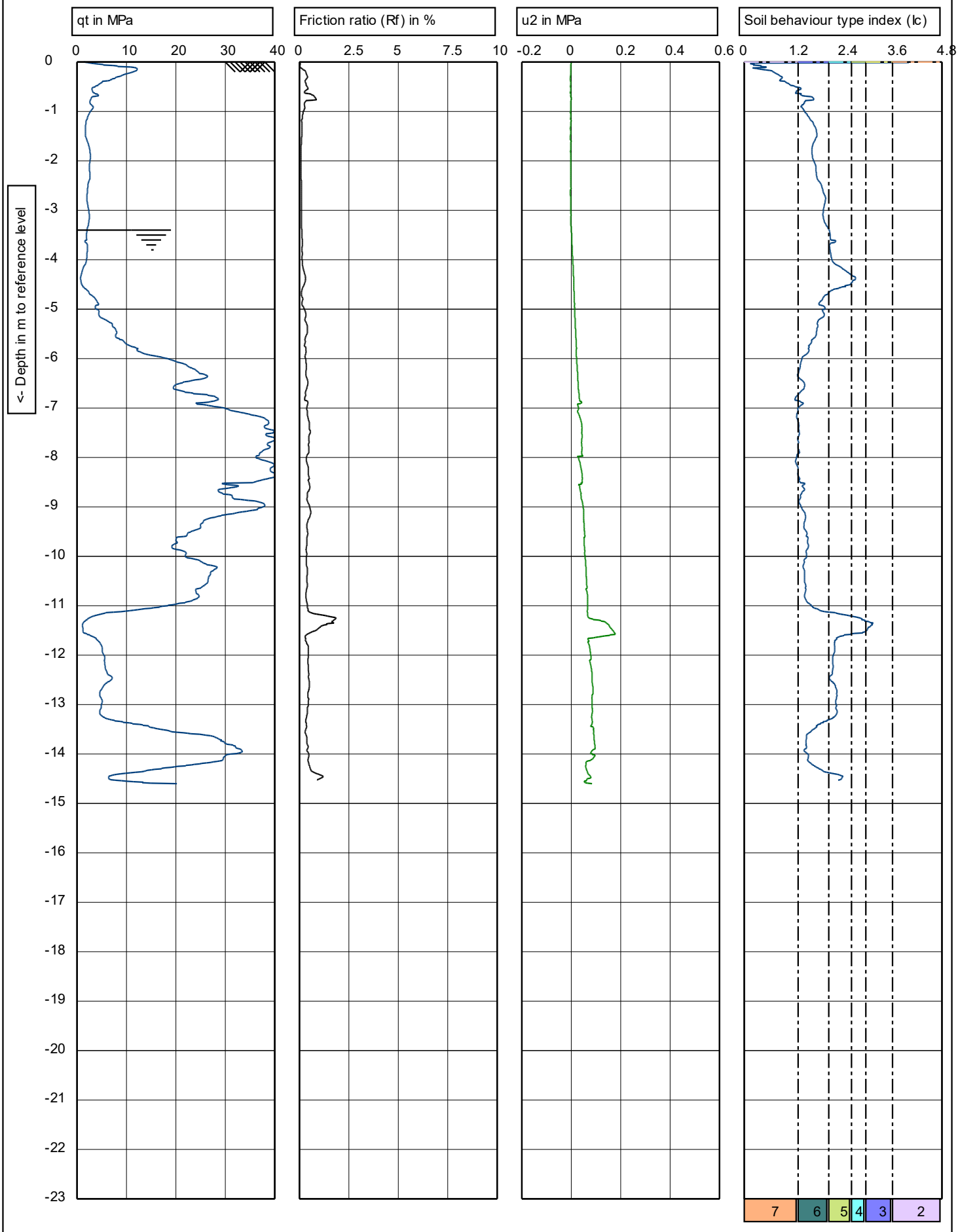
ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

Predrill:	**0.00 m Predrilled**
Date:	**7/07/2022**
Cone no.:	**C10CFIIP.C18245**
Project no.:	
CPT no.:	**CPT-07** **1/3**

1.44



NEWSYD GEOTECHNICAL TESTING
Ph. 0408 292638

ISO 22476-1:2012 Application class 1 Testtype TE1

G.L.: **0.00 m** W.L.: **-3.40 m**

Project: **Geotechnical Investigation**
Location: **CROUNLLA HIGH SCHOOL**
Position: **0, 0**

Predrill: **0.00 m Predrilled**
Date: **7/07/2022**
Cone no.: **C10CFIIP.C18245**
Project no.:
CPT no.: **CPT-07** **2/3**

1.44

(2) Organic soils
(3) Clay
(4) Silt mixture
(5) Sand mixture
(6) Sand clean to silty
(7) Gravelly sand

NEWSYD GEOTECHNICAL TESTING **Ph. 0408 292638**	⌜ u2 └ 150 cm² 10 cm²	ISO 22476-1:2012 Application class 1 Testtype TE1		Predrill:	**0.00 m Predrilled**
		G.L.: **0.00 m**	W.L.: **-3.40 m**	Date:	**7/07/2022**
	Project:	**Geotechnical Investigation**		Cone no.:	**C10CFIIP.C18245**
	Location:	**CROUNLLA HIGH SCHOOL**		Project no.:	
	Position:	**0, 0**		CPT no.:	**CPT-07** **3/3**

1.44

15 Attachment G – DCP ‘N’ Counts

Dynamic Cone Penetrometer Test Log Summary

martens
consulting engineers since 1989

Suite 201, 20 George Street, Hornsby, NSW 2077, Ph: (02) 9476 9999 Fax: (02) 9476 8767, mail@martens.com.au, www.martens.com.au

Site	Cronulla High School	**DCP Group Reference**	P2108205JS02V01
Client	NSW Department of Education c/-SINSW	**Log Date**	22 & 23 /05/2021
Logged by	AG / JRW		
Checked by	KB		
Comments	DCPs commenced at 50 mm BGL.		

TEST DATA

Depth Interval (m)	DCP101	DCP102	DCP103	DCP104	DCP105	DCP106	DCP107	DCP108
0.15	-	HW	2	2	2	HW	HW	1
0.30	-	9	3	2	2	1	2	5
0.45	-	20	3	2	3	9	8	5
0.60	-	13	3	5	4	8	12	5
0.75	-	9	2	4	4	5	12	5
0.90	-	7	4	3	4	5	9	5
1.05	2	7	2	2	2	3	5	4
1.20	2	4	2	2	2	1	3	4
1.35	3	5	2	2	2	3	3	3
1.50	2	5	3	2	3	3	2	3
1.65	1	4	4	2	4	2	3	4
1.80	1	4	3	2	3	2	3	9
1.95	1	5	3	3	4	1	3	12
2.10	1	4	3	3	3	2	3	12
2.25	1	4	4	3	4	2	3	8
2.40	1	3	3	4	3	2	3	9
2.55	1	2	4	3	4	4	3	11
2.70	1	3	4	3	3	5	4	14
2.85	1	4	4	2	3	10	3	20
3.00	1	3	4	2	4	10	3	18
3.15	3	3	6	2	4	8	5	Terminated due to high counts at 3.05 mbgl.
3.30	2	4	7	2	4	8	7	
3.45	1	5	9	1	5	8	8	
3.60	1	6	10	1	5	8	8	
3.75	2	6	8	2	5	7	12	
3.90	3	4	8	2	6	7	12	
4.05	3	16	6	2	7	6	12	
4.20	4	16	8	1	7	9	11	
4.35	5	13	9	2	13	18	12	
4.50	4	11	11	2	8	17	9	
4.65	4	9	11	2	3	Terminated due to target depth reached at 4.55 mbgl.	9	
4.80	5	7	12	5	4		10	
4.95	4	8	13	7	4		14	
5.10	7	9	18	8	6		13	
5.25	10	11	26	10	6		Terminated due to target depth reached at 5.15 mbgl.	
5.40	11	12	Terminated due to high counts at 5.30 mbgl.	11	7			
5.55	12	12		22	9			
5.70	14	12		18	9			
5.85	13	14		Terminated due to high counts at 5.80 mbgl.	9			
6.00	14	20			10			
6.15	20	28			12			
6.30	15	Terminated due to high counts at 6.20 mbgl.			12			
6.45	34				11			
6.60	35 /60 mm				9			
6.75	Terminated due to high counts at 6.59 mbgl.				10			
6.90					11			
7.05					8			
7.20					Terminated due to target depth reached at 7.10 mbgl.			
7.35								
7.50								
7.65								

Dynamic Cone Penetrometer Test Log Summary

martens
consulting engineers since 1989

Suite 201, 20 George Street, Hornsby, NSW 2077, Ph: (02) 9476 9999 Fax: (02) 9476 8767, mail@martens.com.au, www.martens.com. au

Site	Cronulla High School	**DCP Group Reference**	P2108205JS02V01
Client	NSW Department of Education c/-SINSW	**Log Date**	22 & 23 /05/2021
Logged by	AG / JRW		
Checked by	KB		
Comments	DCPs commenced at 50 mm BGL.		

TEST DATA

Depth Interval (m)	DCP109	DCP110						
0.15	HW	2						
0.30	3	1						
0.45	4	3						
0.60	4	11						
0.75	4	Terminated due to double bounce on fill at 0.65 mbgl.						
0.90	5							
1.05	4							
1.20	7							
1.35	8							
1.50	9							
1.65	4							
1.80	3							
1.95	2							
2.10	2							
2.25	2							
2.40	2							
2.55	3							
2.70	3							
2.85	5							
3.00	5							
3.15	Terminated due to target depth reached at 3.05 mbgl.							
3.30								
3.45								
3.60								
3.75								

16 Attachment H – sPOCAS Laboratory Test Results

sPOCAS LABORATORY TEST INTERPRETATION

martens

Suite 201, 20 George Street, Hornsby, NSW 2077, Ph: (02) 9476 9999 Fax: (02) 9476 8767, mail@martens.com.au, www.martens.com .au

Client	NSW Department of Education c/-SINSW	**Page No.**	1 of 1
Project	Geotechnical and Acid Sulphate Soil Assessment	**Assessment Date**	11.06.2021
Sampling Site	Cronulla High School, Cronulla, NSW	**Proceedure**	ST-50
Sampling Date	22 & 23.05.2021	**Job Number**	P2108205
		Sampled By	AG

Assumed Parameters

Gs - Specific gravity (g/cm^3)	2.65
M - Exposed soil mass (t)	455

Sample ID	Sample Depth (m)	Material Type [1]	pH_{KCL} [2]	pH_{OX} [3]	TPA (mol H+/t) [4]	TSA (mol H+/t) [5]	S_{POS} (%S oxidisable) [6]	Final Assessment [7]	Liming Rate (kg $CaCO_3$/t) [8]
		Assessment Criteria: (For exposed soil >1000t, use coarse textured criteria) (F)ine textured; > 40 % clay (M)edium textured; 5-40 % clay (C)oarse textured; < 5 % clay	≤ 4 = AASS	< 3.5 = PASS pH_{KCL}-pH_{OX}>1 = PASS				TPA, TSA, S_{POS} > criteria = PASS	
8205/BH102	1.0-1.1	C	5.2	4.4	<5	<5	0.004	NA	NA
8205/BH102	2.5-2.6	C	5.5	4.9	5	<5	0.004	NA	NA
8205/BH102	4.0-4.1	C	5.6	5.1	<5	<5	0.004	NA	NA
8205/BH102	5.5-5.6	C	6.2	5.8	<5	<5	0.004	NA	NA
8205/BH104	1.5-1.6	C	6.7	5.9	<5	<5	0.004	NA	NA
8205/BH104	2.5-2.6	C	6.7	6.1	<5	<5	0.004	NA	NA
8205/BH104	4.0-4.1	C	6.5	6.0	<5	<5	0.004	NA	NA
8205/BH104	5.5-5.6	C	6.4	5.7	<5	<5	0.004	NA	NA
8205/BH106	0.5-0.6	C	8.9	7.2	<5	<5	0.004	NA	<0.75
8205/BH106	1.5-1.6	C	7.5	6.3	<5	<5	0.004	NA	<0.75

Notes:

1. Material type based on field texture assessment or laboratory report.
2. Field pH (pH_F)or laboratory pH (pH_{KCL}). Highlighted values indicate AASS.
3. Post peroxide oxidation pH. Highlighted values provide a preliminary indication of PASS.
4. Total Potential Acidity. Highlighted values exceed ASSMAC (1998) action criteria.
5. Total Sulfidic Acidity. Highlighted values exceed ASSMAC (1998) action criteria.
6. Percentage oxidisable sulphur. Highlighted values exceed ASSMAC (1998) action criteria.
7. NA = not AASS or PASS, AASS = Actual Acid Sulfate Soil, PASS = Potential Acid Sulfate Soil
8. From laboratory test results (refer to laboratory test certificates).

sPOCAS LABORATORY TEST INTERPRETATION

martens

Suite 201, 20 George Street, Hornsby, NSW 2077, Ph: (02) 9476 9999 Fax: (02) 9476 8767, mail@martens.com.au, www.martens.com.au

Client	NSW Department of Education c/-SINSW	**Page No.**	1 of 1
Project	Geotechnical and Acid Sulphate Soil Assessment	**Assessment Date**	11.06.2021
Sampling Site	Cronulla High School, Cronulla, NSW	**Proceedure**	ST-50
Sampling Date	22 & 23.05.2021	**Job Number**	P2108205
		Sampled By	AG

Assumed Parameters

Gs - Specific gravity (g/cm^3)	2.65
M - Exposed soil mass (t)	455

Sample ID	Sample Depth (m)	Material Type [1]	pH_{KCL} [2]	pH_{OX} [3]	TPA (mol H+/t) [4]	TSA (mol H+/t) [5]	S_{POS} (%S oxidisable) [6]	Final Assessment [7]	Liming Rate (kg $CaCO_3$/t) [8]
		Assessment Criteria: (For exposed soil >1000t, use coarse textured criteria) (F)ine textured; > 40 % clay / (M)edium textured; 5-40 % clay / (C)oarse textured; < 5 % clay	≤ 4 = AASS	< 3.5 = PASS pH_{KCL}-pH_{OX}>1 = PASS				TPA, TSA, S_{POS} > criteria = PASS	
8205/BH106	2.5-2.6	C	6.3	5.7	5	5	0.004	NA	NA
8205/BH108	0.5-0.6	C	5.8	**4.2**	5	5	0.004	NA	<0.75
8205/BH108	1.5-1.6	C	5.7	**4.2**	5	5	0.004	NA	<0.75
8205/BH108	2.5-2.6	C	6.0	**4.1**	5	5	0.004	NA	<0.75

Notes:

1. Material type based on field texture assessment or laboratory report.
2. Field pH (pH_F)or laboratory pH (pH_{KCL}). Highlighted values indicate AASS.
3. Post peroxide oxidation pH. Highlighted values provide a preliminary indication of PASS.
4. Total Potential Acidity. Highlighted values exceed ASSMAC (1998) action criteria.
5. Total Sulfidic Acidity. Highlighted values exceed ASSMAC (1998) action criteria.
6. Percentage oxidisable sulphur. Highlighted values exceed ASSMAC (1998) action criteria.
7. NA = not AASS or PASS, AASS = Actual Acid Sulfate Soil, PASS = Potential Acid Sulfate Soil
8. From laboratory test results (refer to laboratory test certificates).

17 Attachment I – Laboratory Test Certificates

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
ABN: 25 131 532 020
Sydney: 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
Ph: (02) 9674 7711 **| Fax:** (02) 9674 7755 **| Email:** info@resourcelab.com.au

Test Report

Customer: Martens & Associates Pty Ltd
Job number: 21-0076
Project: P2108205
Report number: 1
Location: Cronulla High School, NSW

Particle Size Distribution

Sampling method: Tested as received
Test method(s): AS 1289.1.1, 3.6.1

	Results				
Laboratory sample no.	24543	24544	24545	24546	24547
Customer sample no.	8205/BH101/ 1.3-1.4m	8205/BH105/ 1.0-1.1m	8205/BH105/ 2.5-2.6m	8205/BH108/ 1.0-1.1m	8205/BH110/ 3.0-3.1m
Date sampled	22/05/2021- 23/05/2021	22/05/2021- 23/05/2021	22/05/2021- 23/05/2021	22/05/2021- 23/05/2021	22/05/2021- 23/05/2021
Material description	SAND, trace of gravel and silt, yellow-brown	SAND, trace of gravel and silt, dark brown	SAND, brown	SAND, trace of silt, grey	SAND, trace of gravel and silt, dark brown
% Passing AS Sieve					
75.0mm					
63.0mm					
53.0mm					
37.5mm					
26.5mm	100				
19.0mm	99				100
13.2mm	99	100			99
9.5mm	99	99			99
6.7mm	99	99			98
4.75mm	99	98			97
2.36mm	98	98			95
1.18mm	97	97	100	100	93
600µm	96	96	99	99	91
425µm	91	90	95	93	85
300µm	50	60	64	58	53
150µm	3	7	0	3	7
75µm	2	5	0	2	5

Approved Signatory: C. Greely **Date:** 03/06/2021

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NATA Accredited Laboratory Number: **17062**

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
ABN: 25 131 532 020
Sydney: 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
Ph: (02) 9674 7711 **| Fax:** (02) 9674 7755 **| Email:** info@resourcelab.com.au

Test Report

Customer: Martens & Associates Pty Ltd
Job number: 21-0076
Project: P2108205
Report number: 1
Location: Cronulla High School, NSW

Particle Size Distribution

Sampling method: Tested as received
Test method(s): AS 1289.1.1, 3.6.1

	Results				
Laboratory sample no.	24548				
Customer sample no.	8205/BH110/ 1.5-1.6m				
Date sampled	22/05/2021- 23/05/2021				
Material description	SAND, trace of gravel and silt, dark brown				
% Passing AS Sieve					
75.0mm					
63.0mm					
53.0mm					
37.5mm					
26.5mm	100				
19.0mm	98				
13.2mm	97				
9.5mm	96				
6.7mm	95				
4.75mm	94				
2.36mm	92				
1.18mm	91				
600µm	89				
425µm	83				
300µm	50				
150µm	5				
75µm	4				

Approved Signatory:  C. Greely
Date: 03/06/2021

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Accredited for compliance with ISO/IEC 17025 - Testing.

NATA Accredited Laboratory Number: **17062**

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Ph: (02) 9674 7711 | **Fax:** (02) 9674 7755 | **Email:** info@resourcelab.com.au

Test Report

Customer: Martens & Associates Pty Ltd
Project: P2108205
Location: Cronulla High School, NSW

Job number: 21-0076
Report number: 2
Page: 1 of 1

California Bearing Ratio

Sampling method: Tested as received

Test method(s): AS 1289.1.1, 2.1.1, 5.1.1, 6.1.1

	Results			
Laboratory sample no.	24541	24542		
Customer sample no.	8205/BH109/ 0.2-0.7m	8205/BH110/ 1.0-1.5m		
Date sampled	22/05/2021- 23/05/2021	22/05/2021- 23/05/2021		
Material description	SAND, with silt, brown/pale brown	SAND, with silt, trace of gravel, brown		
Maximum dry density (t/m^3)	1.63	1.65		
Optimum moisture content (%)	16.3	12.7		
Field moisture content (%)	n/a	n/a		
Oversize retained on 19.0mm sieve (%)	0	2		
Minimum curing time (hours)	2	2		
Dry density before soak (t/m^3)	1.59	1.61		
Dry density after soak (t/m^3)	1.60	1.61		
Moisture content before soak (%)	16.5	13.0		
Moisture content after soak (%)	20.4	21.6		
Moisture content after test - top 30mm (%)	18.0	19.9		
Moisture content after test - remaining depth (%)	19.6	21.6		
Density ratio before soaking (%)	98.0	97.5		
Moisture ratio before soaking (%)	101.0	102.0		
Period of soaking (days)	4	4		
Compactive effort	Standard	Standard		
Mass of surcharge applied (kg)	4.5	4.5		
Swell after soaking (%)	0.0	0.0		
Penetration (mm)	2.5	5.0		
CBR Value (%)	**19**	**17**		

Notes: Specified LDR: 98 ±1%

Method of establishing plasticity level - Visual / tactile

Approved Signatory:  C. Greely **Date:** 09/06/2021

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 269824

Client Details

Client	Martens & Associates Pty Ltd
Attention	Jeff Fulton
Address	Suite 201, 20 George St, Hornsby, NSW, 2077

Sample Details

Your Reference	**P2108205COC02V01, Cronulla High School**
Number of Samples	31 Soil
Date samples received	25/05/2021
Date completed instructions received	25/05/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	01/06/2021
Date of Issue	01/06/2021

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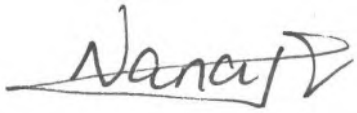
Results Approved By
Diego Bigolin, Team Leader, Inorganics
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

sPOCAS field test						
Our Reference		269824-1	269824-2	269824-3	269824-4	269824-5
Your Reference	UNITS	8205/BH102/1.0-1.1 m	8205/BH102/2.5-2.6 m	8205/BH102/4.0-4.1 m	8205/BH102/5.5-5.6 m	8205/BH104/1.5-1.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021	31/05/2021
Date analysed	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021	31/05/2021
pH_F (field pH test)*	pH Units	5.7	6.2	6.4	7.1	8.0
pH_{FOX} (field peroxide test)*	pH Units	5.4	5.4	5.5	6.2	6.0
Reaction Rate*	-	Low reaction	Low reaction	Low reaction	Low reaction	Low reaction

sPOCAS field test						
Our Reference		269824-6	269824-7	269824-8	269824-9	269824-10
Your Reference	UNITS	8205/BH104/2.5-2.6 m	8205/BH104/4.0-4.1 m	8205/BH104/5.5-5.6 m	8205/BH106/0.5-0.6 m	8205/BH106/1.5-1.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021	31/05/2021
Date analysed	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021	31/05/2021
pH_F (field pH test)*	pH Units	8.0	8.0	8.0	11.0	8.7
pH_{FOX} (field peroxide test)*	pH Units	6.1	6.0	6.1	7.1	6.3
Reaction Rate*	-	Low reaction	Low reaction	Low reaction	Low reaction	Low reaction

sPOCAS field test					
Our Reference		269824-11	269824-12	269824-13	269824-14
Your Reference	UNITS	8205/BH106/2.5-2.6 m	8205/BH108/0.5-0.6 m	8205/BH108/1.5-1.6 m	8205/BH108/2.5-2.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021
Date analysed	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021
pH_F (field pH test)*	pH Units	7.5	7.0	6.7	7.0
pH_{FOX} (field peroxide test)*	pH Units	5.8	5.5	4.9	4.6
Reaction Rate*	-	Low reaction	Low reaction	Low reaction	Low reaction

Soil Aggressivity						
Our Reference		269824-3	269824-4	269824-9	269824-15	269824-16
Your Reference	UNITS	8205/BH102/4.0-4.1 m	8205/BH102/5.5-5.6 m	8205/BH106/0.5-0.6 m	8205/BH101/0.5-0.6 m	8205/BH101/1.0-1.1 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	6.7	7.4	9.9	9.6	8.6
Electrical Conductivity 1:5 soil:water	µS/cm	14	10	86	100	150
Chloride, Cl 1:5 soil:water	mg/kg	<10	10	20	<10	23
Sulphate, SO4 1:5 soil:water	mg/kg	10	10	42	45	59

Soil Aggressivity						
Our Reference		269824-17	269824-18	269824-19	269824-20	269824-21
Your Reference	UNITS	8205/BH101/1.5-1.6 m	8205/BH101/2.5-2.6 m	8205/BH101/4.0-4.1 m	8205/BH102/0.5-0.6 m	8205/BH102/1.5-1.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	9.4	8.0	8.0	6.1	6.6
Electrical Conductivity 1:5 soil:water	µS/cm	220	15	32	7	14
Chloride, Cl 1:5 soil:water	mg/kg	28	<10	10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	130	<10	25	<10	10

Soil Aggressivity						
Our Reference		269824-22	269824-23	269824-24	269824-25	269824-26
Your Reference	UNITS	8205/BH102/2.3-2.4 m	8205/BH103/0.1-0.2 m	8205/BH103/1.0-1.1 m	8205/BH103/2.0-2.1 m	8205/BH103/4.0-4.1 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	6.3	6.7	7.0	6.7	6.8
Electrical Conductivity 1:5 soil:water	µS/cm	33	27	33	31	16
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	21	<10	<10	<10	<10

Soil Aggressivity						
Our Reference		269824-27	269824-28	269824-29	269824-30	269824-31
Your Reference	UNITS	8205/BH103/5.5-5.6 m	8205/BH106/1.0-1.1 m	8205/BH106/2.0-2.1 m	8205/BH106/4.0-4.1 m	8205/BH106/5.5-5.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	7.6	8.2	8.4	7.6	7.8
Electrical Conductivity 1:5 soil:water	µS/cm	11	30	37	8	11
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	<10	10	<10	<10

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: sPOCAS field test						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			[NT]	[NT]	[NT]	[NT]	[NT]	31/05/2021	[NT]
Date analysed	-			[NT]	[NT]	[NT]	[NT]	[NT]	31/05/2021	[NT]
pH_F (field pH test)*	pH Units		Inorg-063	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
pH_{FOX} (field peroxide test)*	pH Units		Inorg-063	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]

QUALITY CONTROL: Soil Aggressivity					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	269824-15
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	4	7.4	7.5	1	101	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	4	10	12	18	105	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	4	10	<10	0	89	102
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	4	10	<10	0	92	115

QUALITY CONTROL: Soil Aggressivity					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-2	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	25	6.7	6.7	0	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	25	31	30	3	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	25	10	10	0	90	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	25	<10	<10	0	91	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 269824

Client Details

Client	Martens & Associates Pty Ltd
Attention	Jeff Fulton
Address	Suite 201, 20 George St, Hornsby, NSW, 2077

Sample Details

Your Reference	**P2108205COC02V01, Cronulla High School**
Number of Samples	31 Soil
Date samples received	25/05/2021
Date completed instructions received	25/05/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	01/06/2021
Date of Issue	18/06/2021
Reissue Details	This report replaces R00 created on 01/06/2021 due to: revised report with resistivityl results added.

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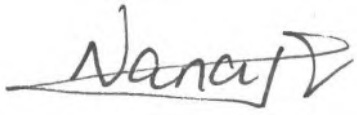
Results Approved By
Diego Bigolin, Team Leader, Inorganics

Authorised By



Nancy Zhang, Laboratory Manager

sPOCAS field test						
Our Reference		269824-1	269824-2	269824-3	269824-4	269824-5
Your Reference	UNITS	8205/BH102/1.0-1.1 m	8205/BH102/2.5-2.6 m	8205/BH102/4.0-4.1 m	8205/BH102/5.5-5.6 m	8205/BH104/1.5-1.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021	31/05/2021
Date analysed	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021	31/05/2021
pH_F (field pH test)*	pH Units	5.7	6.2	6.4	7.1	8.0
pH_{FOX} (field peroxide test)*	pH Units	5.4	5.4	5.5	6.2	6.0
Reaction Rate*	-	Low reaction	Low reaction	Low reaction	Low reaction	Low reaction

sPOCAS field test						
Our Reference		269824-6	269824-7	269824-8	269824-9	269824-10
Your Reference	UNITS	8205/BH104/2.5-2.6 m	8205/BH104/4.0-4.1 m	8205/BH104/5.5-5.6 m	8205/BH106/0.5-0.6 m	8205/BH106/1.5-1.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021	31/05/2021
Date analysed	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021	31/05/2021
pH_F (field pH test)*	pH Units	8.0	8.0	8.0	11.0	8.7
pH_{FOX} (field peroxide test)*	pH Units	6.1	6.0	6.1	7.1	6.3
Reaction Rate*	-	Low reaction	Low reaction	Low reaction	Low reaction	Low reaction

sPOCAS field test					
Our Reference		269824-11	269824-12	269824-13	269824-14
Your Reference	UNITS	8205/BH106/2.5-2.6 m	8205/BH108/0.5-0.6 m	8205/BH108/1.5-1.6 m	8205/BH108/2.5-2.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021
Date analysed	-	31/05/2021	31/05/2021	31/05/2021	31/05/2021
pH_F (field pH test)*	pH Units	7.5	7.0	6.7	7.0
pH_{FOX} (field peroxide test)*	pH Units	5.8	5.5	4.9	4.6
Reaction Rate*	-	Low reaction	Low reaction	Low reaction	Low reaction

Soil Aggressivity						
Our Reference		269824-3	269824-4	269824-9	269824-15	269824-16
Your Reference	UNITS	8205/BH102/4.0-4.1 m	8205/BH102/5.5-5.6 m	8205/BH106/0.5-0.6 m	8205/BH101/0.5-0.6 m	8205/BH101/1.0-1.1 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	6.7	7.4	9.9	9.6	8.6
Electrical Conductivity 1:5 soil:water	µS/cm	14	10	86	100	150
Chloride, Cl 1:5 soil:water	mg/kg	<10	10	20	<10	23
Sulphate, SO4 1:5 soil:water	mg/kg	10	10	42	45	59
Resistivity in soil*	ohm m	690	970	120	98	68

Soil Aggressivity						
Our Reference		269824-17	269824-18	269824-19	269824-20	269824-21
Your Reference	UNITS	8205/BH101/1.5-1.6 m	8205/BH101/2.5-2.6 m	8205/BH101/4.0-4.1 m	8205/BH102/0.5-0.6 m	8205/BH102/1.5-1.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	9.4	8.0	8.0	6.1	6.6
Electrical Conductivity 1:5 soil:water	µS/cm	220	15	32	7	14
Chloride, Cl 1:5 soil:water	mg/kg	28	<10	10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	130	<10	25	<10	10
Resistivity in soil*	ohm m	45	650	310	1,400	700

Soil Aggressivity						
Our Reference		269824-22	269824-23	269824-24	269824-25	269824-26
Your Reference	UNITS	8205/BH102/2.3-2.4 m	8205/BH103/0.1-0.2 m	8205/BH103/1.0-1.1 m	8205/BH103/2.0-2.1 m	8205/BH103/4.0-4.1 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	6.3	6.7	7.0	6.7	6.8
Electrical Conductivity 1:5 soil:water	µS/cm	33	27	33	31	16
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	21	<10	<10	<10	<10
Resistivity in soil*	ohm m	300	370	310	330	630

Soil Aggressivity						
Our Reference		269824-27	269824-28	269824-29	269824-30	269824-31
Your Reference	UNITS	8205/BH103/5.5-5.6 m	8205/BH106/1.0-1.1 m	8205/BH106/2.0-2.1 m	8205/BH106/4.0-4.1 m	8205/BH106/5.5-5.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	7.6	8.2	8.4	7.6	7.8
Electrical Conductivity 1:5 soil:water	µS/cm	11	30	37	8	11
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	<10	10	<10	<10
Resistivity in soil*	ohm m	940	330	270	1,200	930

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: sPOCAS field test						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			[NT]	[NT]	[NT]	[NT]	[NT]	31/05/2021	[NT]
Date analysed	-			[NT]	[NT]	[NT]	[NT]	[NT]	31/05/2021	[NT]
pH_F (field pH test)*	pH Units		Inorg-063	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
pH_{FOX} (field peroxide test)*	pH Units		Inorg-063	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]

QUALITY CONTROL: Soil Aggressivity					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	269824-15
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	4	7.4	7.5	1	101	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	4	10	12	18	105	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	4	10	<10	0	89	102
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	4	10	<10	0	92	115
Resistivity in soil*	ohm m	1	Inorg-002	<1	4	970	860	12	[NT]	[NT]

QUALITY CONTROL: Soil Aggressivity					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-2	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	25	6.7	6.7	0	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	25	31	30	3	102	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	25	10	10	0	90	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	25	<10	<10	0	91	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	[NT]	25	330	330	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 269824-A

Client Details

Client	Martens & Associates Pty Ltd
Attention	Jeff Fulton
Address	Suite 201, 20 George St, Hornsby, NSW, 2077

Sample Details

Your Reference	**P2108205COC02V01, Cronulla High School**
Number of Samples	additional analyses
Date samples received	25/05/2021
Date completed instructions received	02/06/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	07/06/2021
Date of Issue	04/06/2021

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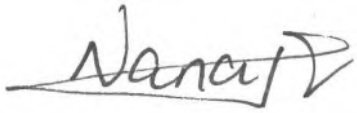
Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

sPOCAS + %S w/w						
Our Reference		269824-A-1	269824-A-2	269824-A-3	269824-A-4	269824-A-5
Your Reference	UNITS	8205/BH102/1.0-1.1 m	8205/BH102/2.5-2.6 m	8205/BH102/4.0-4.1 m	8205/BH102/5.5-5.6 m	8205/BH104/1.5-1.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	02/06/2021	02/06/2021	02/06/2021	02/06/2021	02/06/2021
Date analysed	-	02/06/2021	02/06/2021	02/06/2021	02/06/2021	02/06/2021
pH $_{kcl}$	pH units	5.2	5.5	5.6	6.2	6.7
TAA pH 6.5	moles H^+ /t	<5	<5	<5	<5	<5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
pH $_{Ox}$	pH units	4.4	4.9	5.1	5.8	5.9
TPA pH 6.5	moles H^+ /t	<5	5	<5	<5	<5
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
TSA pH 6.5	moles H^+ /t	<5	<5	<5	<5	<5
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
ANC_E	% $CaCO_3$	[NT]	[NT]	[NT]	[NT]	[NT]
a-ANC_E	moles H^+ /t	[NT]	[NT]	[NT]	[NT]	[NT]
s-ANC_E	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
S_{KCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
S_P	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
S_{POS}	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
a-S_{POS}	moles H^+ /t	<5	<5	<5	<5	<5
Ca_{KCl}	%w/w	<0.005	<0.005	<0.005	<0.005	0.03
Ca_P	%w/w	<0.005	<0.005	<0.005	<0.005	0.04
Ca_A	%w/w	<0.005	<0.005	<0.005	<0.005	0.009
Mg_{KCl}	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg_P	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg_A	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
S_{HCl}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
S_{NAS}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
a-S_{NAS}	moles H^+ /t	[NT]	[NT]	[NT]	[NT]	[NT]
s-S_{NAS}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+ /t	<5	<5	<5	<5	<5
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
Liming rate	kg $CaCO_3$ /t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity without -ANCE	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity without ANCE	moles H^+ /t	<5	<5	<5	<5	<5
Liming rate without ANCE	kg $CaCO_3$ /t	<0.75	<0.75	<0.75	<0.75	<0.75

sPOCAS + %S w/w						
Our Reference		269824-A-6	269824-A-7	269824-A-8	269824-A-9	269824-A-10
Your Reference	UNITS	8205/BH104/2.5-2.6 m	8205/BH104/4.0-4.1 m	8205/BH104/5.5-5.6 m	8205/BH106/0.5-0.6 m	8205/BH106/1.5-1.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	02/06/2021	02/06/2021	02/06/2021	02/06/2021	02/06/2021
Date analysed	-	02/06/2021	02/06/2021	02/06/2021	02/06/2021	02/06/2021
pH $_{kcl}$	pH units	6.7	6.5	6.4	8.9	7.5
TAA pH 6.5	moles H^+ /t	<5	<5	<5	<5	<5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
pH $_{Ox}$	pH units	6.1	6.0	5.7	7.2	6.3
TPA pH 6.5	moles H^+ /t	<5	<5	<5	<5	<5
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
TSA pH 6.5	moles H^+ /t	<5	<5	<5	<5	<5
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
ANC_E	% $CaCO_3$	[NT]	[NT]	[NT]	0.38	[NT]
a-ANC_E	moles H^+ /t	[NT]	[NT]	[NT]	75	[NT]
s-ANC_E	%w/w S	[NT]	[NT]	[NT]	0.12	[NT]
S_{KCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
S_P	%w/w	<0.005	<0.005	<0.005	0.005	<0.005
S_{POS}	%w/w	<0.005	<0.005	<0.005	0.005	<0.005
a-S_{POS}	moles H^+ /t	<5	<5	<5	<5	<5
Ca_{KCl}	%w/w	0.02	0.01	0.008	0.08	0.04
Ca_P	%w/w	0.02	0.01	0.01	0.19	0.05
Ca_A	%w/w	<0.005	<0.005	<0.005	0.10	0.011
Mg_{KCl}	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg_P	%w/w	<0.005	<0.005	<0.005	0.006	<0.005
Mg_A	%w/w	<0.005	<0.005	<0.005	0.006	<0.005
S_{HCl}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
S_{NAS}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
a-S_{NAS}	moles H^+ /t	[NT]	[NT]	[NT]	[NT]	[NT]
s-S_{NAS}	%w/w S	[NT]	[NT]	[NT]	[NT]	[NT]
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+ /t	<5	<5	<5	<5	<5
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
Liming rate	kg $CaCO_3$ /t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity without -ANCE	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity without ANCE	moles H^+ /t	<5	<5	<5	<5	<5
Liming rate without ANCE	kg $CaCO_3$ /t	<0.75	<0.75	<0.75	<0.75	<0.75

sPOCAS + %S w/w					
Our Reference		269824-A-11	269824-A-12	269824-A-13	269824-A-14
Your Reference	UNITS	8205/BH106/2.5-2.6 m	8205/BH108/0.5-0.6 m	8205/BH108/1.5-1.6 m	8205/BH108/2.5-2.6 m
Date Sampled		22-23/05/21	22-23/05/21	22-23/05/21	22-23/05/21
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	02/06/2021	02/06/2021	02/06/2021	02/06/2021
Date analysed	-	02/06/2021	02/06/2021	02/06/2021	02/06/2021
pH $_{kcl}$	pH units	6.3	5.8	5.7	6.0
TAA pH 6.5	moles H^+ /t	<5	<5	<5	<5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01
pH $_{Ox}$	pH units	5.7	4.2	4.2	4.1
TPA pH 6.5	moles H^+ /t	<5	<5	<5	<5
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01
TSA pH 6.5	moles H^+ /t	<5	<5	<5	<5
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01
ANC_E	% $CaCO_3$	[NT]	[NT]	[NT]	[NT]
a-ANC_E	moles H^+ /t	[NT]	[NT]	[NT]	[NT]
s-ANC_E	%w/w S	[NT]	[NT]	[NT]	[NT]
S_{KCl}	%w/w S	<0.005	<0.005	<0.005	<0.005
S_P	%w/w	<0.005	<0.005	<0.005	<0.005
S_{POS}	%w/w	<0.005	<0.005	<0.005	<0.005
a-S_{POS}	moles H^+ /t	<5	<5	<5	<5
Ca_{KCl}	%w/w	0.01	0.008	0.03	0.02
Ca_P	%w/w	0.01	0.009	0.03	0.02
Ca_A	%w/w	<0.005	<0.005	<0.005	<0.005
Mg_{KCl}	%w/w	<0.005	<0.005	<0.005	<0.005
Mg_P	%w/w	<0.005	<0.005	<0.005	<0.005
Mg_A	%w/w	<0.005	<0.005	<0.005	<0.005
S_{HCl}	%w/w S	[NT]	[NT]	[NT]	[NT]
S_{NAS}	%w/w S	[NT]	[NT]	[NT]	[NT]
a-S_{NAS}	moles H^+ /t	[NT]	[NT]	[NT]	[NT]
s-S_{NAS}	%w/w S	[NT]	[NT]	[NT]	[NT]
Fineness Factor	-	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+ /t	<5	<5	<5	<5
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01	<0.01
Liming rate	kg $CaCO_3$ /t	<0.75	<0.75	<0.75	<0.75
s-Net Acidity without -ANCE	%w/w S	<0.01	<0.01	<0.01	<0.01
a-Net Acidity without ANCE	moles H^+ /t	<5	<5	<5	<5
Liming rate without ANCE	kg $CaCO_3$ /t	<0.75	<0.75	<0.75	<0.75

Method ID	Methodology Summary
Inorg-064	sPOCAS determined using titrimetric and ICP-AES techniques. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL: sPOCAS + %S w/w						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			02/06/2021	1	02/06/2021	02/06/2021		02/06/2021	[NT]
Date analysed	-			02/06/2021	1	02/06/2021	02/06/2021		02/06/2021	[NT]
pH $_{kcl}$	pH units		Inorg-064	[NT]	1	5.2	5.1	2	96	[NT]
TAA pH 6.5	moles H^+ /t	5	Inorg-064	<5	1	<5	<5	0	100	[NT]
s-TAA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	1	<0.01	<0.01	0	[NT]	[NT]
pH $_{Ox}$	pH units		Inorg-064	[NT]	1	4.4	4.3	2	90	[NT]
TPA pH 6.5	moles H^+ /t	5	Inorg-064	<5	1	<5	<5	0	98	[NT]
s-TPA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	1	<0.01	<0.01	0	[NT]	[NT]
TSA pH 6.5	moles H^+ /t	5	Inorg-064	<5	1	<5	<5	0	[NT]	[NT]
s-TSA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	1	<0.01	<0.01	0	[NT]	[NT]
ANC_E	% $CaCO_3$	0.05	Inorg-064	<0.05	1	[NT]	[NT]		[NT]	[NT]
a-ANC_E	moles H^+ /t	5	Inorg-064	<5	1	[NT]	[NT]		[NT]	[NT]
s-ANC_E	%w/w S	0.05	Inorg-064	<0.05	1	[NT]	[NT]		[NT]	[NT]
S_{KCl}	%w/w S	0.005	Inorg-064	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
S_P	%w/w	0.005	Inorg-064	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
S_{POS}	%w/w	0.005	Inorg-064	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
a-S_{POS}	moles H^+ /t	5	Inorg-064	<5	1	<5	<5	0	[NT]	[NT]
Ca_{KCl}	%w/w	0.005	Inorg-064	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
Ca_P	%w/w	0.005	Inorg-064	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
Ca_A	%w/w	0.005	Inorg-064	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
Mg_{KCl}	%w/w	0.005	Inorg-064	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
Mg_P	%w/w	0.005	Inorg-064	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
Mg_A	%w/w	0.005	Inorg-064	<0.005	1	<0.005	<0.005	0	[NT]	[NT]
S_{HCl}	%w/w S	0.005	Inorg-064	<0.005	1	[NT]	[NT]		[NT]	[NT]
S_{NAS}	%w/w S	0.005	Inorg-064	<0.005	1	[NT]	[NT]		[NT]	[NT]
a-S_{NAS}	moles H^+ /t	5	Inorg-064	<5	1	[NT]	[NT]		[NT]	[NT]
s-S_{NAS}	%w/w S	0.01	Inorg-064	<0.01	1	[NT]	[NT]		[NT]	[NT]
Fineness Factor	-	1.5	Inorg-064	<1.5	1	1.5	1.5	0	[NT]	[NT]
a-Net Acidity	moles H^+ /t	5	Inorg-064	<5	1	<5	<5	0	[NT]	[NT]
s-Net Acidity	%w/w S	0.01	Inorg-064	<0.01	1	<0.01	<0.01	0	[NT]	[NT]
Liming rate	kg $CaCO_3$ /t	0.75	Inorg-064	<0.75	1	<0.75	<0.75	0	[NT]	[NT]
s-Net Acidity without -ANCE	%w/w S	0.01	Inorg-064	<0.01	1	<0.01	<0.01	0	[NT]	[NT]

QUALITY CONTROL: sPOCAS + %S w/w						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
a-Net Acidity without ANCE	moles H^+ /t	5	Inorg-064	<5	1	<5	<5	0	[NT]	[NT]
Liming rate without ANCE	kg $CaCO_3$ /t	0.75	Inorg-064	<0.75	1	<0.75	<0.75	0	[NT]	[NT]

QUALITY CONTROL: sPOCAS + %S w/w					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	11	02/06/2021	02/06/2021		[NT]	[NT]
Date analysed	-			[NT]	11	02/06/2021	02/06/2021		[NT]	[NT]
pH $_{kcl}$	pH units		Inorg-064	[NT]	11	6.3	6.3	0	[NT]	[NT]
TAA pH 6.5	moles H^+ /t	5	Inorg-064	[NT]	11	<5	<5	0	[NT]	[NT]
s-TAA pH 6.5	%w/w S	0.01	Inorg-064	[NT]	11	<0.01	<0.01	0	[NT]	[NT]
pH $_{Ox}$	pH units		Inorg-064	[NT]	11	5.7	5.7	0	[NT]	[NT]
TPA pH 6.5	moles H^+ /t	5	Inorg-064	[NT]	11	<5	<5	0	[NT]	[NT]
s-TPA pH 6.5	%w/w S	0.01	Inorg-064	[NT]	11	<0.01	<0.01	0	[NT]	[NT]
TSA pH 6.5	moles H^+ /t	5	Inorg-064	[NT]	11	<5	<5	0	[NT]	[NT]
s-TSA pH 6.5	%w/w S	0.01	Inorg-064	[NT]	11	<0.01	<0.01	0	[NT]	[NT]
S_{KCl}	%w/w S	0.005	Inorg-064	[NT]	11	<0.005	<0.005	0	[NT]	[NT]
S_P	%w/w	0.005	Inorg-064	[NT]	11	<0.005	<0.005	0	[NT]	[NT]
S_{POS}	%w/w	0.005	Inorg-064	[NT]	11	<0.005	<0.005	0	[NT]	[NT]
a-S_{POS}	moles H^+ /t	5	Inorg-064	[NT]	11	<5	<5	0	[NT]	[NT]
Ca_{KCl}	%w/w	0.005	Inorg-064	[NT]	11	0.01	0.008	22	[NT]	[NT]
Ca_P	%w/w	0.005	Inorg-064	[NT]	11	0.01	0.009	11	[NT]	[NT]
Ca_A	%w/w	0.005	Inorg-064	[NT]	11	<0.005	<0.005	0	[NT]	[NT]
Mg_{KCl}	%w/w	0.005	Inorg-064	[NT]	11	<0.005	<0.005	0	[NT]	[NT]
Mg_P	%w/w	0.005	Inorg-064	[NT]	11	<0.005	<0.005	0	[NT]	[NT]
Mg_A	%w/w	0.005	Inorg-064	[NT]	11	<0.005	<0.005	0	[NT]	[NT]
Fineness Factor	-	1.5	Inorg-064	[NT]	11	1.5	1.5	0	[NT]	[NT]
a-Net Acidity	moles H^+ /t	5	Inorg-064	[NT]	11	<5	<5	0	[NT]	[NT]
s-Net Acidity	%w/w S	0.01	Inorg-064	[NT]	11	<0.01	<0.01	0	[NT]	[NT]
Liming rate	kg $CaCO_3$ /t	0.75	Inorg-064	[NT]	11	<0.75	<0.75	0	[NT]	[NT]
s-Net Acidity without -ANCE	%w/w S	0.01	Inorg-064	[NT]	11	<0.01	<0.01	0	[NT]	[NT]
a-Net Acidity without ANCE	moles H^+ /t	5	Inorg-064	[NT]	11	<5	<5	0	[NT]	[NT]
Liming rate without ANCE	kg $CaCO_3$ /t	0.75	Inorg-064	[NT]	11	<0.75	<0.75	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

18 Attachment J – General Geotechnical Recommendations

Geotechnical Recommendations

Important Recommendations About Your Site (1 of 2)

These general geotechnical recommendations have been prepared by Martens to help you deliver a safe work site, to comply with your obligations, and to deliver your project. Not all are necessarily relevant to this report but are included as general reference. Any specific recommendations made in the report will override these recommendations.

Batter Slopes

Excavations in soil and extremely low to very low strength rock exceeding 0.75 m depth should be battered back at grades of no greater than 1 Vertical (V) : 2 Horizontal (H) for temporary slopes (unsupported for less than 1 month) and 1 V : 3 H for longer term unsupported slopes.

Vertical excavation may be carried out in medium or higher strength rock, where encountered, subject to inspection and confirmation by a geotechnical engineer. Long term and short term unsupported batters should be protected against erosion and rock weathering due to, for example, stormwater run-off.

Batter angles may need to be revised depending on the presence of bedding partings or adversely oriented joints in the exposed rock, and are subject to on-site inspection and confirmation by a geotechnical engineer. Unsupported excavations deeper than 1.0 m should be assessed by a geotechnical engineer for slope instability risk.

Any excavated rock faces should be inspected during construction by a geotechnical engineer to determine whether any additional support, such as rock bolts or shotcrete, is required.

Earthworks

Earthworks should be carried out following removal of any unsuitable materials and in accordance with AS3798 (2007). A qualified geotechnical engineer should inspect the condition of prepared surfaces to assess suitability as foundation for future fill placement or load application.

Earthworks inspections and compliance testing should be carried out in accordance with Sections 5 and 8 of AS3798 (2007), with testing to be carried out by a National Association of Testing Authorities (NATA) accredited testing laboratory.

Excavations

All excavation work should be completed with reference to the *Work Health and Safety (Excavation Work) Code of Practice (2015)*, by Safe Work Australia. Excavations into rock may be undertaken as follows:

1. Extremely low to low strength rock - conventional hydraulic earthmoving equipment.

2. Medium strength or stronger rock - hydraulic earthmoving equipment with rock hammer or ripping tyne attachment.

Exposed rock faces and loose boulders should be monitored to assess risk of block / boulder movement, particularly as a result of excavation vibrations.

Fill

Subject to any specific recommendations provided in this report, any fill imported to site is to comprise approved material with maximum particle size of two thirds the final layer thickness. Fill should be placed in horizontal layers of not more than 300 mm loose thickness, however, the layer thickness should be appropriate for the adopted compaction plant.

Foundations

All exposed foundations should be inspected by a geotechnical engineer prior to footing construction to confirm encountered conditions satisfy design assumptions and that the base of all excavations is free from loose or softened material and water. Water that has ponded in the base of excavations and any resultant softened material is to be removed prior to footing construction.

Footings should be constructed with minimal delay following excavation. If a delay in construction is anticipated, we recommend placing a concrete blinding layer of at least 50 mm thickness in shallow footings or mass concrete in piers / piles to protect exposed foundations.

A geotechnical engineer should confirm any design bearing capacity values, by further assessment during construction, as necessary.

Shoring - Anchors

Where there is a requirement for either soil or rock anchors, or soil nailing, and these structures penetrate past a property boundary, appropriate permission from the adjoining land owner must be obtained prior to the installation of these structures.

Shoring - Permanent

Permanent shoring techniques may be used as an alternative to temporary shoring. The design of such structures should be in accordance with the findings of this report and any further testing recommended by this report. Permanent shoring may include [but not be limited to] reinforced block work walls, contiguous and semi contiguous pile walls, secant pile walls and soldier pile walls with or without reinforced shotcrete infill panels. The choice of shoring system will depend on the type of structure, project budget and site specific geotechnical conditions.

Permanent shoring systems are to be engineer designed and backfilled with suitable granular

material and free-draining drainage material. Backfill should be placed in maximum 100 mm thick layers compacted using a hand operated compactor. Care should be taken to ensure excessive compaction stresses are not transferred to retaining walls.

Shoring design should consider any surcharge loading from sloping / raised ground behind shoring structures, live loads, new structures, construction equipment, backfill compaction and static water pressures. All shoring systems shall be provided with adequate foundation designs.

Suitable drainage measures, such as geotextile enclosed 100 mm agricultural pipes embedded in free-draining gravel, should be included to redirect water that may collect behind the shoring structure to a suitable discharge point.

Shoring - Temporary

In the absence of providing acceptable excavation batters, excavations should be supported by suitably designed and installed temporary shoring / retaining structures to limit lateral deflection of excavation faces and associated ground surface settlements.

Soil Erosion Control

Removal of any soil overburden should be performed in a manner that reduces the risk of sedimentation occurring in any formal stormwater drainage system, on neighbouring land and in receiving waters. Where possible, this may be achieved by one or more of the following means:

1. Maintain vegetation where possible
2. Disturb minimal areas during excavation
3. Revegetate disturbed areas if possible

All spoil on site should be properly controlled by erosion control measures to prevent transportation of sediments off-site. Appropriate soil erosion control methods in accordance with Landcom (2004) shall be required.

Trafficability and Access

Consideration should be given to the impact of the proposed works and site subsurface conditions on trafficability within the site e.g. wet clay soils will lead to poor trafficability by tyred plant or vehicles.

Where site access is likely to be affected by any site works, construction staging should be organised such that any impacts on adequate access are minimised as best as possible.

Vibration Management

Where excavation is to be extended into medium or higher strength rock, care will be required when using a rock hammer to limit potential structural distress from excavation-induced vibrations where nearby structures may be affected by the works.

To limit vibrations, we recommend limiting rock hammer size and set frequency, and setting the hammer parallel to bedding planes and along defect planes, where possible, or as advised by a geotechnical engineer. We recommend limiting vibration peak particle velocities (PPV) caused by construction equipment or resulting from excavation at the site to 5 mm/s (AS 2187.2, 2006, Appendix J).

Waste – Spoil and Water

Soil to be disposed off-site should be classified in accordance with the relevant State Authority guidelines and requirements.

Any collected waste stormwater or groundwater should also be tested prior to discharge to ensure contaminant levels (where applicable) are appropriate for the nominated discharge location.

MA can complete the necessary classification and testing if required. Time allowance should be made for such testing in the construction program.

Water Management - Groundwater

If the proposed works are likely to intersect ephemeral or permanent groundwater levels, the management of any potential acid soil drainage should be considered. If groundwater tables are likely to be lowered, this should be further discussed with the relevant State Government Agency.

Water Management – Surface Water

All surface runoff should be diverted away from excavation areas during construction works and prevented from accumulating in areas surrounding any retaining structures, footings or the base of excavations.

Any collected surface water should be discharged into a suitable Council approved drainage system and not adversely impact downslope surface and subsurface conditions.

All site discharges should be passed through a filter material prior to release. Sump and pump methods will generally be suitable for collection and removal of accumulated surface water within any excavations.

Contingency Plan

In the event that proposed development works cause an adverse impact on geotechnical hazards, overall site stability or adjacent properties, the following actions are to be undertaken:

1. Works shall cease immediately.
2. The nature of the impact shall be documented and the reason(s) for the adverse impact investigated.
3. A qualified geotechnical engineer should be consulted to provide further advice in relation to the issue.

19 Attachment K – Notes About This Report

Information

Important Information About Your Report (1 of 2)

These notes have been prepared by Martens to help you interpret and understand the limitations of your report. Not all are necessarily relevant to all reports but are included as general reference.

Engineering Reports - Limitations

The recommendations presented in this report are based on limited investigations and include specific issues to be addressed during various phases of the project. If the recommendations presented in this report are not implemented in full, the general recommendations may become inapplicable and Martens & Associates accept no responsibility whatsoever for the performance of the works undertaken.

Occasionally, sub-surface conditions between and below the completed boreholes or other tests may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact Martens & Associates.

Relative ground surface levels at borehole locations may not be accurate and should be verified by on-site survey.

Engineering Reports – Project Specific Criteria

Engineering reports are prepared by qualified personnel. They are based on information obtained, on current engineering standards of interpretation and analysis, and on the basis of your unique project specific requirements as understood by Martens. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the Client.

Where the report has been prepared for a specific design proposal (e.g. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (e.g. to a twenty storey building). Your report should not be relied upon, if there are changes to the project, without first asking Martens to assess how factors, which changed subsequent to the date of the report, affect the report's recommendations. Martens will not accept responsibility for problems that may occur due to design changes, if not consulted.

Engineering Reports – Recommendations

Your report is based on the assumption that site conditions, as may be revealed through selective point sampling, are indicative of actual conditions throughout an area. This assumption often cannot be substantiated until project implementation has commenced. Therefore your site investigation report recommendations should only be regarded as preliminary.

Only Martens, who prepared the report, are fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report, there is a risk that the report will be misinterpreted and Martens cannot be held responsible for such misinterpretation.

Engineering Reports – Use for Tendering Purposes

Where information obtained from investigations is provided for tendering purposes, Martens recommend that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document.

Martens would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Engineering Reports – Data

The report as a whole presents the findings of a site assessment and should not be copied in part or altered in any way.

Logs, figures, drawings *etc* are customarily included in a Martens report and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), desktop studies and laboratory evaluation of field samples. These data should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Engineering Reports – Other Projects

To avoid misuse of the information contained in your report it is recommended that you confer with Martens before passing your report on to another party who may not be familiar with the background and purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Subsurface Conditions - General

Every care is taken with the report in relation to interpretation of subsurface conditions, discussion of geotechnical aspects, relevant standards and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions - the potential will depend partly on test point (eg. excavation or borehole) spacing and sampling frequency, which are often limited by project imposed budgetary constraints.

Important Information About Your Report (2 of 2)

- Changes in guidelines, standards and policy or interpretation of guidelines, standards and policy by statutory authorities.
- The actions of contractors responding to commercial pressures.
- Actual conditions differing somewhat from those inferred to exist, because no professional, no matter how qualified, can reveal precisely what is hidden by earth, rock and time.

  The actual interface between logged materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

If these conditions occur, Martens will be pleased to assist with investigation or providing advice to resolve the matter.

Subsurface Conditions - Changes

Natural processes and the activity of man create subsurface conditions. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Reports are based on conditions which existed at the time of the subsurface exploration / assessment.

Decisions should not be based on a report whose adequacy may have been affected by time. If an extended period of time has elapsed since the report was prepared, consult Martens to be advised how time may have impacted on the project.

Subsurface Conditions - Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those that were expected from the information contained in the report, Martens requests that it immediately be notified. Most problems are much more readily resolved at the time when conditions are exposed, rather than at some later stage well after the event.

Report Use by Other Design Professionals

To avoid potentially costly misinterpretations when other design professionals develop their plans based on a Martens report, retain Martens to work with other project professionals affected by the report. This may involve Martens explaining the report design implications and then reviewing plans and specifications produced to see how they have incorporated the report findings.

Subsurface Conditions – Geo-environmental Issues

Your report generally does not relate to any findings, conclusions, or recommendations about the potential for hazardous or contaminated materials existing at the site unless specifically required to do so as part of Martens' proposal for works.

Specific sampling guidelines and specialist equipment, techniques and personnel are typically used to perform geo-environmental or site contamination assessments. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Martens for information relating to such matters.

Responsibility

Geo-environmental reporting relies on interpretation of factual information based on professional judgment and opinion and has an inherent level of uncertainty attached to it and is typically far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded.

To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Martens to other parties but are included to identify where Martens' responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Martens closely and do not hesitate to ask any questions you may have.

Site Inspections

Martens will always be pleased to provide engineering inspection services for aspects of work to which this report relates. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site. Martens is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction.

Soil Data

Explanation of Terms (1 of 3)

Definitions

In engineering terms, soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material does not exhibit any visible rock properties and can be remoulded or disintegrated by hand in its field condition or in water, it is described as a soil. Other materials are described using rock description terms.

The methods of description and classification of soils and rocks used in this report are typically based on Australian Standard 1726 and the Unified Soil Classification System (USCS) – refer Soil Data Explanation of Terms (2 of 3). In general, descriptions cover the following properties: strength or density, colour, moisture, structure, soil or rock type and inclusions.

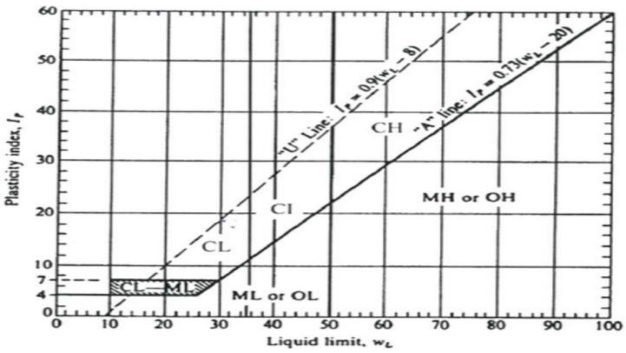
Particle Size

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (e.g. sandy CLAY). Unless otherwise stated, particle size is described in accordance with the following table.

Division	Subdivision		Particle Size (mm)
Oversized	BOULDERS		>200
	COBBLES		63 to 200
Coarse Grained Soil	GRAVEL	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	SAND	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine Grained Soil	SILT		0.002 to 0.075
	CLAY		< 0.002

Plasticity Properties

Plasticity properties of cohesive soils can be assessed in the field by tactile properties or by laboratory procedures.



Soil Moisture Condition

Coarse Grained (Granular) Soil:

Dry (D):	Looks and feels dry. Cemented soils are hard, friable or powdery. Uncemented soils run freely through fingers.
Moist (M):	Feels cool and damp and is darkened in colour. Particles tend to cohere.
Wet (W):	As for moist but with free water forming on hands when handled.

Fine Grained (Cohesive) Soil:

Moist, dry of plastic limit[1] (w < PL):	Looks and feels dry. Hard, friable or powdery.
Moist, near plastic limit (w ≈ PL):	Can be moulded, feels cool and damp, is darkened in colour, at a moisture content approximately equal to the PL.
Moist, wet of plastic limit (w > PL):	Usually weakened and free water forms on hands when handled.
Wet, near liquid limit[2] (w ≈ LL)	
Wet, wet of liquid limit (w > LL)	

[1] Plastic Limit (PL): Moisture content at which soil becomes too dry to be in a plastic condition.

[2] Liquid Limit (LL): Moisture content at which soil passes from plastic to liquid state.

Consistency of Cohesive Soils

Cohesive soils refer to predominantly clay materials.
(Note: consistency is affected by soil moisture condition at time of measurement)

Term	C_u (kPa)	Field Guide
Very Soft (VS)	≤12	A finger can be pushed well into the soil with little effort. Sample exudes between fingers when squeezed in fist.
Soft (S)	>12 and ≤25	A finger can be pushed into the soil to about 25mm depth. Easily moulded by light finger pressures.
Firm (F)	>25 and ≤50	The soil can be indented about 5mm with the thumb, but not penetrated. Can be moulded by strong figure pressure.
Stiff (St)	>50 and ≤100	The surface of the soil can be indented with the thumb, but not penetrated. Cannot be moulded by fingers.
Very Stiff (VSt)	>100 and ≤200	The surface of the soil can be marked, but not indented with thumb pressure. Difficult to cut with a knife. Thumbnail can readily indent.
Hard (H)	> 200	The surface of the soil can only be marked with the thumbnail. Brittle. Tends to break into fragments.
Friable (Fr)	-	Crumbles or powders when scraped by thumbnail. Can easily be crumbled or broken into small pieces by hand.

Density of Granular Soils

Non-cohesive soils are classified on the basis of relative density, generally from standard penetration test (SPT) or Dutch cone penetrometer test (CPT) results as below:

Relative Density	%	SPT 'N' Value* (blows/300mm)	CPT Cone Value (q_c MPa)
Very loose	≤15	< 5	< 2
Loose	>15 and ≤35	5 - 10	2 - 5
Medium dense	>35 and ≤65	10 - 30	5 - 15
Dense	>65 and ≤85	30 - 50	15 - 25
Very dense	> 85	> 50	> 25

* Values may be subject to corrections for overburden pressures and equipment type and influenced by soil moisture condition at time of measurement.

Minor Components

Minor components in soils may be present and readily detectable, but have little bearing on general geotechnical classification. Terms include:

Description of components	Proportion of component in:					
	coarse grained soil				fine grained soil	
	% Fines	Terminology	% Accessory coarse fraction	Terminology	% Sand/ gravel	Terminology
Minor	≤5	Trace clay / silt, as applicable	≤15	Trace sand / gravel, as applicable	≤15	Trace sand / gravel, as applicable
	>5,≤12	With clay / silt, as applicable	>15,≤30	With sand / gravel, as applicable	>5,≤30	With sand / gravel, as applicable
Secondary	>12	Prefix soil name as 'silty' or 'clayey', as applicable	>30	Prefix soil name as 'sandy' or 'gravelly', as applicable	>30	Prefix soil name as 'sandy' or 'gravelly', as applicable

Soil Data

Explanation of Terms (2 of 3)

martens consulting engineers

Symbols for Soils and Other

SOILS


COBBLES/BOULDERS


GRAVEL (GP or GW)


Silty GRAVEL (GM)


Clayey GRAVEL (GC)


SAND (SP or SW)


Silty SAND (SM)


Clayey SAND (SC)


SILT (ML or MH)


ORGANIC SILT or CLAY (OH or OL)


CLAY (CL, CI or CH)


Silty CLAY


Sandy CLAY


PEAT (Pt)


Gravelly CLAY

OTHER


FILL


TALUS


ASPHALT


CONCRETE


TOPSOIL

Unified Soil Classification Scheme (USCS)

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)					USCS	Primary Name
COARSE GRAINED SOILS More than 65 % of material less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.36 mm.	GRAVEL and GRAVEL-SAND Mixtures (≤ 5% fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes; not enough fines to bind coarse grains; no dry strength	GW	GRAVEL
				Predominantly one size or a range of sizes with some intermediate sizes missing; not enough fines to bind coarse grains; no dry strength	GP	GRAVEL
			GRAVEL-SILT and GRAVEL-SAND-SILT mixtures (≥ 12% fines) [1]	With excess non-plastic fines (for identification procedures see ML below); zero to medium dry strength; may also contain sand	GM	Silty GRAVEL
				With excess plastic fines (for identification procedures see CL below); medium to high dry strength; may also contain sand	GC	Clayey GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.36 mm	SAND and GRAVEL-SAND mixtures (≤5% fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes; not enough fines to bind coarse grains; no dry strength.	SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing; not enough fines to bind coarse grains; no dry strength	SP	SAND
			SAND-SILT and SAND-CLAY mixtures (≥ 12% fines) [1]	With excess non-plastic fines (for identification procedures see ML below); zero to medium dry strength;	SM	Silty SAND
				With excess plastic fines (for identification procedures see CL below); medium to high dry strength	SC	Clayey SAND

FINE GRAINED SOILS More than 35 % of material less than 63 mm is smaller than 0.075 mm	IDENTIFICATION PROCEDURES ON FRACTIONS < 0.2 MM					
	DRY STRENGTH (Crushing Characteristics)	DILATANCY	TOUGHNESS	DESCRIPTION	USCS	Primary Name
	None to Low	Quick to Slow	Low	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or silt with low plasticity [2]	ML	SILT [3]
	Medium to High	None to Slow	Medium	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays	CL (or CI[4])	CLAY
	Low to Medium	Slow	Low	Organic slits and organic silty clays of low plasticity	OL	Organic SILT or CLAY
	Low to Medium	None to Slow	Low to Medium	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	MH	SILT [3]
	High to Very High	None	High	Inorganic clays of high plasticity, fat clays	CH	CLAY
	Medium to High	None to Very Slow	Low to Medium	Organic clays of medium to high plasticity, organic silt of high plasticity	OH	Organic SILT or CLAY
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture				Pt	PEAT

Notes:

1. Between 5% and 12% - dual classification, e.g. GP-GM.
2. Low Plasticity Clay – Liquid Limit W_L ≤35%; Medium Plasticity Clay – Liquid limit W_L >35%, ≤50%; High Plasticity Clay - Liquid limit W_L > 50%.
3. Low Plasticity Silt – Liquid Limit W_L ≤50%; High Plasticity Silt - Liquid limit W_L > 50%.
4. CI may be adopted for clay of medium plasticity to distinguish from clay of low plasticity.

Soil Data

Explanation of Terms (3 of 3)

Soil Agricultural Classification Scheme

In some situations, such as where soils are to be used for effluent disposal purposes, soils are often more appropriately classified in terms of traditional agricultural classification schemes. Where a Martens report provides agricultural classifications, these are undertaken in accordance with descriptions by Northcote, K.H. (1979) *The factual key for the recognition of Australian Soils*, Rellim Technical Publications, NSW, p 26 - 28.

Symbol	Field Texture Grade	Behaviour of moist bolus	Ribbon length	Clay content (%)
S	Sand	Coherence nil to very slight; cannot be moulded; single grains adhere to fingers	0 mm	< 5
LS	Loamy sand	Slight coherence; discolours fingers with dark organic stain	6.35 mm	5
CLS	Clayey sand	Slight coherence; sticky when wet; many sand grains stick to fingers; discolours fingers with clay stain	6.35mm - 1.3cm	5 - 10
SL	Sandy loam	Bolus just coherent but very sandy to touch; dominant sand grains are of medium size and are readily visible	1.3 - 2.5	10 - 15
FSL	Fine sandy loam	Bolus coherent; fine sand can be felt and heard	1.3 - 2.5	10 - 20
SCL-	Light sandy clay loam	Bolus strongly coherent but sandy to touch, sand grains dominantly medium size and easily visible	2.0	15 - 20
L	Loam	Bolus coherent and rather spongy; smooth feel when manipulated but no obvious sandiness or silkiness; may be somewhat greasy to the touch if much organic matter present	2.5	25
Lfsy	Loam, fine sandy	Bolus coherent and slightly spongy; fine sand can be felt and heard when manipulated	2.5	25
SiL	Silt loam	Coherent bolus, very smooth to silky when manipulated	2.5	25 + > 25 silt
SCL	Sandy clay loam	Strongly coherent bolus sandy to touch; medium size sand grains visible in a finer matrix	2.5 - 3.8	20 - 30
CL	Clay loam	Coherent plastic bolus; smooth to manipulate	3.8 - 5.0	30 - 35
SiCL	Silty clay loam	Coherent smooth bolus; plastic and silky to touch	3.8 - 5.0	30- 35 + > 25 silt
FSCL	Fine sandy clay loam	Coherent bolus; fine sand can be felt and heard	3.8 - 5.0	30 - 35
SC	Sandy clay	Plastic bolus; fine to medium sized sands can be seen, felt or heard in a clayey matrix	5.0 - 7.5	35 - 40
SiC	Silty clay	Plastic bolus; smooth and silky	5.0 - 7.5	35 - 40 + > 25 silt
LC	Light clay	Plastic bolus; smooth to touch; slight resistance to shearing	5.0 - 7.5	35 - 40
LMC	Light medium clay	Plastic bolus; smooth to touch, slightly greater resistance to shearing than LC	7.5	40 - 45
MC	Medium clay	Smooth plastic bolus, handles like plasticine and can be moulded into rods without fracture, some resistance to shearing	> 7.5	45 - 55
HC	Heavy clay	Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to shearing	> 7.5	> 50

Rock Data

Explanation of Terms (1 of 2)

Symbols for Rock

SEDIMENTARY ROCK


BRECCIA


CONGLOMERATE


CONGLOMERATIC SANDSTONE


SANDSTONE/QUARTZITE


SILTSTONE


MUDSTONE/CLAYSTONE


SHALE


COAL


LIMESTONE


LITHIC TUFF

IGNEOUS ROCK


GRANITE


DOLERITE/BASALT

METAMORPHIC ROCK


SLATE, PHYLLITE, SCHIST


GNEISS


METASANDSTONE


METASILTSTONE


METAMUDSTONE

Definitions

Descriptive terms used for Rock by Martens are based on AS1726 and encompass rock substance, defects and mass.

Rock Material	The intact rock that is bounded by defects.
Rock Defect	Discontinuity, fracture, break or void in the material or minerals across which there is little or no tensile strength.
Rock Structure	The nature and configuration of the different defects within the rock mass and their relationship to each other.
Rock Mass	The entirety of the system formed by all of the rock material and all of the defects that are present.

Degree of Weathering

Rock weathering is defined as the degree of decline in rock structure and grain property and can be determined in the field.

Term	Symbol	Definition
Residual soil[1]	RS	Material is weathered to such an extent that it has soil properties. Mass structure, material texture, and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered[1]	XW	Material is weathered to such an extent that it has soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System. Mass structure and material texture and fabric of original rock are still visible.
Highly weathered[2]	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the original colour of the rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered[2]	MW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the rock is not recognisable. Rock strength shows little or no change from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	Rock substance unaffected by weathering. No sign of decomposition of individual materials or colour changes.

Notes:
1 RS and EW material is described using soil descriptive terms.
2. The term "Distinctly Weathered" (DW) may be used to cover the range of substance weathering between EW and SW

Rock Strength

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the loading. The test procedure is described by the International Society of Rock Mechanics.

Term (Strength)	I_s (50) MPa	Uniaxial Compressive Strength MPa	Field Guide	Symbol
Very low	>0.03 ≤0.1	0.6 – 2	May be crumbled in the hand. Sandstone is 'sugary' and friable.	VL
Low	>0.1 ≤0.3	2 – 6	Core 150mm long x 50mm diameter may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	L
Medium	>0.3 ≤1.0	6 – 20	Core 150mm long x 50mm diameter can be broken by hand with considerable difficulty. Readily scored with a knife.	M
High	>1 ≤3	20 – 60	Core 150mm long x 50mm diameter cannot be broken by unaided hands, can be slightly scratched or scored with a knife. Breaks with single blow from pick.	H
Very high	>3 ≤10	60 – 200	Core 150mm long x 50mm diameter, broken readily with hand held hammer. Cannot be scratched with knife. Breaks after more than one pick strike.	VH
Extremely high	>10	>200	A piece of core 150mm long x 50mm diameter is difficult to break with hand held hammer. Rings when struck with a hammer.	EH

Rock Data

Explanation of Terms (2 of 2)

Degree of Fracturing

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude fractures such as drilling breaks (DB) or handling breaks (HB).

Term	Description
Fragmented	The core is comprised primarily of fragments of length less than 20 mm, and mostly of width less than core diameter.
Highly fractured	Core lengths are generally less than 20 mm to 40 mm with occasional fragments.
Fractured	Core lengths are mainly 30 mm to 100 mm with occasional shorter and longer sections.
Slightly fractured	Core lengths are generally 300 mm to 1000 mm, with occasional longer sections and sections of 100 mm to 300 mm.
Unbroken	The core does not contain any fractures.

Rock Core Recovery

TCR = Total Core Recovery

$$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100\,\%$$

SCR = Solid Core Recovery

$$= \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100\,\%$$

RQD = Rock Quality Designation

$$= \frac{\sum \text{Axial lengths of core} > 100 \text{ mm long}}{\text{Length of core run}} \times 100\,\%$$

Rock Strength Tests

- ▼ Point load strength Index (Is50) - axial test (MPa)
- ▶ Point load strength Index (Is50) - diametral test (MPa)
- ● Uniaxial compressive strength (UCS) (MPa)

Defect Type Abbreviations and Descriptions

Defect Type (with inclination given)

BP	Bedding plane parting
FL	Foliation
CL	Cleavage
JT	Joint
FC	Fracture
SZ/SS	Sheared zone/ seam (Fault)
CZ/CS	Crushed zone/ seam
DZ/DS	Decomposed zone/ seam
FZ	Fractured Zone
IS	Infilled seam
VN	Vein
CO	Contact
HB	Handling break
DB	Drilling break

Planarity

Pl	Planar
Cu	Curved
Un	Undulating
St	Stepped
Ir	Irregular
Dis	Discontinuous

Roughness

Pol	Polished
Sl	Slickensided
Sm	Smooth
Ro	Rough
VR	Very rough

Thickness

Zone	> 100 mm
Seam	> 2 mm < 100 mm
Plane	< 2 mm

Coating or Filling

Cn	Clean
Sn	Stain
Ct	Coating
Vnr	Veneer
Fe	Iron Oxide
X	Carbonaceous
Qz	Quartzite
MU	Unidentified mineral

Inclination

Inclination of defect is measured from perpendicular to and down the core axis.
Direction of defect is measured clockwise (looking down core) from magnetic north.

Test, Drill and Excavation Methods

Explanation of Terms (1 of 3)

Sampling

Sampling is carried out during drilling or excavation to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling or excavation provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples may be taken by pushing a thin-walled sampling tube, e.g. U_{50} (50 mm internal diameter thin walled tube), into soils and withdrawing a soil sample in a relatively undisturbed state. Such samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Other sampling methods may be used. Details of the type and method of sampling are given in the report.

Drilling / Excavation Methods

The following is a brief summary of drilling and excavation methods currently adopted by the Company and some comments on their use and application.

Hand Excavation - in some situations, excavation using hand tools, such as mattock and spade, may be required due to limited site access or shallow soil profiles.

Hand Auger - the hole is advanced by pushing and rotating either a sand or clay auger, generally 75-100 mm in diameter, into the ground. The penetration depth is usually limited to the length of the auger pole; however extender pieces can be added to lengthen this.

Test Pits - these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils and, if it is safe to descend into the pit, collection of bulk disturbed samples. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (e.g. Pengo) - the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling (Push Tube) - the hole is advanced by pushing a 50 - 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength *etc.* is only marginally affected.

Continuous Spiral Flight Augers - the hole is advanced using 90 - 115 mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface or, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling - the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling - similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling - a continuous core sample is obtained using a diamond tipped core barrel of usually 50 mm internal diameter. Provided full core recovery is achieved (not always possible in very weak or fractured rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

In-situ Testing and Interpretation

Cone Penetrometer Testing (CPT)

Cone penetrometer testing (sometimes referred to as Dutch Cone) described in this report has been carried out using an electrical friction cone penetrometer.

The test is described in AS 1289.6.5.1-1999 (R2013). In the test, a 35 mm diameter rod with a cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system.

Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the push rod centre to an amplifier and recorder unit mounted on the control truck. As penetration occurs (at a rate of approximately 20 mm per second) the information is output on continuous chart recorders. The plotted results given in this report have been traced from the original records. The information provided on the charts comprises:

(i) Cone resistance (q_c) - the actual end bearing force divided by the cross sectional area of the cone, expressed in MPa.

(ii) Sleeve friction (q_f) - the frictional force of the sleeve divided by the surface area, expressed in kPa.

(iii) Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower (A) scale (0 - 5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main (B) scale (0 - 50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1 % - 2 % are commonly encountered in sands and very soft clays rising to 4 % - 10 % in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6)\ N \text{ (blows/300 mm)}$$

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:

$$q_c = (12 \text{ to } 18)\ C_u$$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes *etc.* This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Standard Penetration Testing (SPT)

Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample.

The test procedure is described in AS 1289.6.3.1-2004. The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm penetration depth increments and the 'N' value is taken as the number of blows for the last two 150 mm depth increments (300 mm total penetration). In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued. The test results are reported in the following form:

(i) Where full 450 mm penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7 blows:

as 4, 6, 7
N = 13

(ii) Where the test is discontinued, short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm

as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

Dynamic Cone (Hand) Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150mm increments of penetration. Normally, there is a depth limitation of 1.2m but this may be extended in certain conditions by the use of extension rods. Two relatively similar tests are used.

Perth sand penetrometer (PSP) - a 16 mm diameter flat ended rod is driven with a 9 kg hammer, dropping 600 mm. The test, described in AS 1289.6.3.3-1997 (R2013), was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

Cone penetrometer (DCP) - sometimes known as the Scala Penetrometer, a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm. The test, described in AS 1289.6.3.2-1997 (R2013), was developed initially for pavement sub-grade investigations, with correlations of the test results with California Bearing Ratio published by various Road Authorities.

Pocket Penetrometers

The pocket (hand) penetrometer (PP) is typically a light weight spring hand operated device with a stainless steel loading piston, used to estimate unconfined compressive strength, q_u, (UCS in kPa) of a fine grained soil in field conditions. In use, the free end of the piston is pressed into the soil at a uniform penetration rate until a line, engraved near the piston tip, reaches the soil surface level. The reading is taken from a gradation scale, which is attached to the piston via a built-in spring mechanism and calibrated to kilograms per square centimetre (kPa) UCS. The UCS measurements are used to evaluate consistency of the soil in the field moisture condition. The results may be used to assess the undrained shear strength, C_u, of fine grained soil using the approximate relationship:

$$q_u = 2 \times C_u.$$

It should be noted that accuracy of the results may be influenced by condition variations at selected test surfaces. Also, the readings obtained from the PP test are based on a small area of penetration and could give misleading results. They should not replace laboratory test results. The use of the results from this test is typically limited to an assessment of consistency of the soil in the field and not used directly for design of foundations.

Test Pit / Borehole Logs

Test pit / borehole log(s) presented herein are an engineering and / or geological interpretation of the subsurface conditions. Their reliability will depend to some extent on frequency of sampling and methods of excavation / drilling. Ideally, continuous undisturbed sampling or excavation / core drilling will provide the most reliable assessment but this is not always practicable, or possible to justify on economic grounds. In any case, the test pit / borehole logs represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of test pits / boreholes, the frequency of sampling and the possibility of other than 'straight line' variation between the test pits / boreholes.

Laboratory Testing

Laboratory testing is carried out in accordance with AS 1289 Methods of Testing Soil for Engineering Purposes. Details of the test procedure used are given on the individual report forms.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems:

- In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent prior weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes, which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Test, Drill and Excavation Methods

Explanation of Terms (3 of 3)

DRILLING / EXCAVATION METHOD

HA	Hand Auger	RD	Rotary Blade or Drag Bit	NQ	Diamond Core - 47 mm
AD/V	Auger Drilling with V-bit	RT	Rotary Tricone bit	NMLC	Diamond Core – 51.9 mm
AD/T	Auger Drilling with TC-Bit	RAB	Rotary Air Blast	HQ	Diamond Core – 63.5 mm
AS	Auger Screwing	RC	Reverse Circulation	HMLC	Diamond Core – 63.5 mm
HSA	Hollow Stem Auger	CT	Cable Tool Rig	DT	Diatube Coring
S	Excavated by Hand Spade	PT	Push Tube	NDD	Non-destructive digging
BH	Tractor Mounted Backhoe	PC	Percussion	PQ	Diamond Core - 83 mm
JET	Jetting	E	Tracked Hydraulic Excavator	X	Existing Excavation

SUPPORT

Nil	No support	S	Shotcrete	RB	Rock Bolt
C	Casing	Sh	Shoring	SN	Soil Nail
WB	Wash bore with Blade or Bailer	WR	Wash bore with Roller	T	Timbering

WATER

▽ Water level at date shown

▷ Water inflow

◁ Partial water loss

◀ Complete water loss

GROUNDWATER NOT OBSERVED (NO)	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUNDWATER NOT ENCOUNTERED (NX)	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

PENETRATION / EXCAVATION RESISTANCE

L	Low resistance: Rapid penetration possible with little effort from the equipment used.
M	Medium resistance: Excavation possible at an acceptable rate with moderate effort from the equipment used.
H	High resistance: Further penetration possible at slow rate & requires significant effort equipment.
R	Refusal/ Practical Refusal. No further progress possible without risk of damage/ unacceptable wear to digging implement / machine.

These assessments are subjective and dependent on many factors, including equipment power, weight, condition of excavation or drilling tools, and operator experience.

SAMPLING

D	Small disturbed sample	W	Water Sample	C	Core sample
B	Bulk disturbed sample	G	Gas Sample	CONC	Concrete Core

U63 Thin walled tube sample - number indicates nominal undisturbed sample diameter in millimetres

TESTING

SPT 4,7,11 N=18	Standard Penetration Test to AS1289.6.3.1-2004 4,7,11 = Blows per 150mm. 'N' = Recorded blows per 300mm penetration following 150mm seating
DCP	Dynamic Cone Penetration test to AS1289.6.3.2-1997. 'n' = Recorded blows per 150mm penetration

Notes:

RW	Penetration occurred under rod weight only
HW	Penetration occurred under hammer and rod weight only
20/100mm	Where practical refusal or hammer double bouncing occurred, blows and penetration for that interval are reported (e.g. 20 blows for 100 mm penetration)

CPT	Static cone penetration test
CPTu	CPT with pore pressure (u) measurement
PP	Pocket penetrometer test expressed as instrument reading (kPa)
FP	Field permeability test over section noted
VS	Field vane shear test expressed as uncorrected shear strength (sv = peak value, sr = residual value)
PM	Pressuremeter test over section noted
PID	Photoionisation Detector reading in ppm
WPT	Water pressure tests

SOIL DESCRIPTION

Density		Consistency		Moisture	
VL	Very loose	VS	Very soft	D	Dry
L	Loose	S	Soft	M	Moist
MD	Medium dense	F	Firm	W	Wet
D	Dense	St	Stiff	Wp	Plastic limit
VD	Very dense	VSt	Very stiff	Wl	Liquid limit
		H	Hard		

ROCK DESCRIPTION

Strength		Weathering	
VL	Very low	EW	Extremely weathered
L	Low	HW	Highly weathered
M	Medium	MW	Moderately weathered
H	High	SW	Slightly weathered
VH	Very high	FR	Fresh
EH	Extremely high		